AUTOMATIC AND EFFORTFUL MEMORY PROCESSING BY STUDENTS WITH AND WITHOUT MENTAL RETARDATION

By

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The purpose of the study was to examine information and memory processing by students with and without mental retardation. Two objectives were stated. The first objective was to determine if differences in effortful and automatic processing existed as hypothesized from the theory of automaticity. The second objective was to determine if memory processing differed by developmental level dependent upon (a) whether the information was automatically or effortfully processed or (b) whether clustering or semantic strategies were applied.

In this study, a picture recall and relocation test was completed. Students (N=180) aged 10 through 15 were participants in the study. The students represented three developmental levels: students classified as trainable mentally handicapped, educable mentally handicapped, and

students without mental retardation. Within each developmental level, students were randomly assigned to one of three encoding conditions: nonsemantic, semantic, or clustered. A follow-up test was conducted approximately 24 hours following the initial examination. A split-plot ANOVA with repeated measures was conducted to analyze immediate and 24-hour delayed recall and relocation performance.

The analysis revealed significant differences in the number of pictures correctly recalled and relocated. Students without mental retardation recalled and relocated more pictures correctly than students classified as educable mentally handicapped who recalled and relocated more than trainable mentally handicapped students. Significant interaction effects resulted when retention interval was included in the analysis. As relocation performance, a test of automatic encoding of spatial location, was not insensitive to the intervening variables of developmental level and encoding condition, the theory of automaticity could not be supported.

The results of this investigation may contribute to increased precision in the design of educational programs for adolescents with mental retardation. Conclusions and recommendations for further research are provided.

CHAPTER 1
INTRODUCTION

The focus of the study reported herin was memory and information processing by persons with mental retardation. Memory processing is crucial in the development of intellectual behavior, problem-solving abilities, and adaptive functioning (Turnure, 1991). Memory has been defined as (a) the retaining and recalling of past experiences, (b) the capacity to behave in a way modified by past experiences, or (c) the power to reproduce or recall what has been learned (Katims, 1987a).

Researchers of theories of information processing assert that memory is determined either by (a) the structure of memory, (b) the use of memory strategies, or (c) the level of processing. Structural features of memory refer to those aspects of the memory system which are not programmable. These structures cannot be varied or changed, although structural capacities may emerge as a function of age and experience (Brown, 1974). Memory strategies, called control processes, may include the use of such techniques as rehearsal, mnemonics, clustering, and semantic stories to increase recall (Katims, 1987a). The level-of-processing approach recognizes the importance of both strategies and prior experiences in information processing (Craik &

Lockhart, 1972). According to the control processes and level-of-processing approaches, recall is enhanced by the use of strategies to increase information organization, by deeper processing, which includes semantic processing, and by elaboration techniques (Schwartz & Reisberg, 1991). Memory-processing theories based on the structural deficits approach are used to define mental retardation. Approaches based on strategic deficits are used to develop techniques to improve learning and memory performance (Lupart & Mulcahy, 1979). The theoretical framework for these three approaches to memory processing are reviewed in more detail in Chapter 2.

Additionally, it is hypothesized that memory is influenced by how information is acquired or encoded. In the theory of automaticity, Hasher and Zacks (1979, 1984) described two types of mental or cognitive processes: effortful and automatic. Effortful encoding involves strategic processes in the intentional application of such operations as clustering, imagery, rehearsal, and elaboration. Automatic processes, on the other hand, occur incidentally, without attention or awareness (Posner & Snyder, 1975). Automatic processes are used to encode such item attributes as spatial location, frequency, and temporal order and are not sensitive to encoding variables or individual differences (Hasher & Zacks, 1979, 1984).

Differences in memory processing experienced by persons with mental retardation have been the subject of prior

investigations. From these research efforts, persons with mental retardation have been reported to be deficient in (a) structural processes, (b) the spontaneous use of adequate control processes, (c) active mediational devices, and (d) the ability to strategically transform input (Brown, 1974). Early research into the memory capacities of students with mental retardation was focused on the structure of memory functioning. Differences in memory performance between persons with and without mental retardation were interpreted to be either developmental differences resulting from slower mental development and a lower level of attainment or differences resulting from a deficiency in one or more cognitive processes. Later researchers deemphasized structural-based processing and concentrated on the use of control processes (Ellis, Meador, & Bodfish, 1985; Glidden, Bilsky, Mar, Judd, & Warner, 1983). Investigators reported the ability to use control strategies spontaneously may not develop until early adolescence and may be further delayed for persons with mental retardation (Brown, 1974).

Although the findings of these early research efforts have contributed significantly to the understanding of mental retardation, changes have been noted in the population of students involved in these studies. MacMillan (1989) reported that research literature published in the 1960s and early 1970s, which serves as a basis for current understanding of the cognitive characteristics of persons with mental retardation, was conducted with samples of

students with educable mental handicaps. This population generally included persons with intelligence quotient (IQ) scores close to, or exceeding, the current upper limit for defining mental retardation and who had been long-term residents of large institutions (Forness & Kavale, 1993). A large percentage of these study participants had cultural-familial retardation and, therefore, cognitively resembled their nonretarded peers. As the functioning level of students currently classified with mental retardation differs from the samples used in the original studies, MacMillan (1989) urged caution in extrapolating findings of these early studies to today's population as the "time-period specific validity . . . may be of little relevance for current educators" (p. 13). Turnure (1991) urged the inclusion of students with more severe disabilities in the study of memory processing to increase the appreciation of individual differences and to analyze and understand the learning processes of the variations in mental retardation subgoups.

In addition, the current emphasis on placing students from all developmental levels in regular classrooms with nonretarded peers of similar chronological age was not addressed by early researchers. Comparative data generally available from previous research equate persons with mental retardation with persons with similar mental ages, college students, or the elderly (Diech, 1974; Dugas & Kellas, 1974; Ellis, Woodley-Zanthos, & Dulaney, 1989a; Lamberts, 1979;

Merrill, 1992). Detterman (1979) questioned this approach in reviewing previous methodological flaws in the study of memory of persons with mental retardation. Bray and Ferguson (1976) reported that performance differences noted when comparing persons with mental retardation and persons matched for mental age may be attributable to previous task-related or situational experiences. Turnure (1991) pointed out that previous studies of automatic encoding and retention were completed with heterogeneous populations, a practice that limits comparisons, generalizations, and usefulness in applying results to educationally relevant situations.

Detterman (1979) reviewed the importance of studying memory functioning of persons with mental retardation. From a review of previous research efforts, Detterman concluded that a better understanding of memory can lead to (a) increased knowledge of intellectual functioning and how the mind operates, (b) a better understanding of the source of individual differences and prescriptions for rectifying differences not based solely on IQ scores, and (c) clarification of how the memory processes of persons with mental retardation differ from persons without retardation. According to Detterman, the study of memory of persons with mental retardation contributes to increased precision in assessment and intervention and provides a theoretical basis in developing remedial techniques.

This study was designed to examine the effortful and automatic information processing by students with and without mental retardation. In their theoretical framework of automaticity, Hasher and Zacks (1979, 1984) hypothesized that memory for spatial location should not benefit from either encoding variables (instructions) or individual differences. The use of strategic behaviors or strategic tactics is reported to be inadequate in persons with mental retardation, but it is not known how the use of these behaviors varies by developmental level (Belmont & Mitchell, 1987; Brown 1974). Therefore, students classified with educable mental handicaps (EMH), trainable mental handicaps (TMH), and peers without mental retardation of similar chronological age were included in the present study to determine if memory processing is similar for these three groups.

Objectives

The objectives of the study were twofold: The first objective was to investigate if differences in effortful and automatic processing exist as hypothesized by Hasher and Zacks' theory of automaticity (1979, 1984). The second objective was to determine if the memory processing of persons with and without mental retardation differs by developmental level dependent upon (a) whether the information was automatically or effortfully processed or (b) whether clustering or semantic strategies were applied.

As has been suggested, the model presented by Hasher and Zacks differentiates effortful and automatic processing. Effortful memory functions are voluntary and intentional and require considerable memory capacity. Automatic functions, on the other hand, occur without intention, function at a constant level under all circumstances, and require minimal cognitive energy. Encoding of item recognition requires effortful processing, while frequency of occurrence and item location have been found to be automatically encoded (Ellis, Katz, & Williams, 1987; Ellis & Allison, 1988; Hasher & Zacks, 1979, 1984). In this study, effortful processing was determined by recall of item information. Memory for spatial location was used to test automatic processing. According to this model, only effortful processes were expected to be enhanced by the use of control strategies and to be sensitive to developmental trends (Ellis et al., 1987; Katz, 1987).

Rationale

Theoretical Rationale

Researchers of general theories of information processing assert that memory is determined either by (a) the structure of memory, (b) the use of memory strategies, or (c) the level of processing. For persons with mental retardation, deficits have been described as an interrelatedness of these factors. Meador and Ellis (1987) hypothesized that the differential performance of persons with mental retardation and their nonretarded peers on

short-term memory tasks is due to deficits in both conscious, effortful processes and in the automatic aspects of encoding. In this study, automatic and effortful processing and control strategy use were investigated relative to developmental level.

Researchers of automatic, or incidental, learning report that memory that does not depend on strategic processes is developmentally insensitive (Brown, 1974). Involuntary memory is the result of incidental learning and accompanies active exploration of the environment. Automatic processing requires minimal attentional resources and does not tap memory capacity (Katz, 1987). According to Hasher and Zacks (1979, 1984), both frequency of occurrence and spatial location can be successfully encoded automatically as well by persons with mental retardation as by their nonretarded peers.

In contrast with incidental learning, voluntary memory is reported to develop gradually as a child develops. Gradual development from involuntary, passive memory to voluntary or active memory parallels the hypothesis that intentional strategy use is dependant on maturity level. Performance differences between persons with mental retardation and nonretarded peers have been found to occur under task conditions that require the active use of semantic techniques or require cognitive effort (Brown, 1974; Merrill, 1990).

Persons with mental retardation may apply strategies differently, fail to adopt strategies for information processing, or inadequately integrate more than one dimension from stimuli to solve problems (Brown, 1974). As performance improved following strategy instruction supplied by Belmont and Mitchell (1987), these researchers concluded that persons with mental retardation were not deficient in the ability to apply memory strategies. Deficiencies resulted from the use of different techniques to apply strategies. Bray and Turner (1987) supported the findings of Belmont and Mitchell and concurred that most strategic deficiencies of persons with mental retardation were performance anomalies rather than production deficiencies. Ellis (1970) and Gerjuoy and Spitz (1966) hypothesized that performance problems, which result in deficient use of short-term memory storage, vary with intelligence and show developmental changes.

Educational Rationale

In addition to theoretical significance, various educational implications may be derived from the results of this investigation for both classroom teachers and educational leaders. Prior researchers of memory processing provided evidence that original learning conditions are important aspects of recall (Turnure, 1991). Other factors such as the use of study time to increase strategy use (Turner & Bray, 1985) and perceptions of task difficulty (Belmont & Mitchell, 1987) also can mediate strategic

behaviors and memory effectiveness. Results from this study may clarify and extend previous information on structuring learning situations to increase the effectiveness of classroom instruction, especially classrooms for students of various developmental levels.

Current focus on normalization and functional skill training has accentuated the need to develop more effective strategies for helping people with mental retardation recall more adaptive information such as telephone numbers, street addresses, or job task lists (Kramer, Nagle, & Engle, 1980). An increased understanding of the processing of relocation and frequency of occurrence data can guide instruction in such adaptive areas as shopping and completion of work tasks (Ellis et al., 1989a). Understanding the hypothesized distinction between automatic and effortful encoding of temporal cues will help devise training programs employing techniques using the cues of size, shape, or location to mediate differences in learning.

Additionally, the increased understanding of memory processing furnished by this study is important to persons in educational leadership positions. Educational leadership, particularly the administration of special educational programs, has evolved as the field of special education has experienced a period of developmental maturation (Lipp, 1992). Administrators increasingly are required to be instructional leaders and managers for all students (Van Horn, Burrello, & DeClue (1992). The American

Association of School Administrators (AASA) (1991) has documented the changing role of school leaders. According to AASA, a leader in a restructured school needs increased knowledge and skills in curriculum content and development, pedagogy, and theories of education. Effective leadership, therefore, requires information about curriculum, instructional devices, modes of instruction, and related services to meet the individual needs of all students (Biklen & Taylor, 1985).

The increased understanding of memory-processing functions gained in this study can contribute to leadership development as called for by AASA. This understanding of memory processing will enable the school administrator to (a) provide guidance in program development and curricula decisions, (b) provide teacher support and advance professional development opportunities, (c) develop communication among general and special educators, specialists, and parents, (d) act as a change agent in developing programs and policies, allocating resources, and evaluating outcomes, and (e) review and assist in development of individual educational plans (Biklen & Taylor, 1985; Lipp, 1992; Van Horn et al., 1992).

Definition of Terms

Automatic processing is the incidental processing of information with minimal attention or awareness. In the present study, automatic processing was assessed by recall for spatial location.

Clustered encoding is using a patterning technique that involves grouping items by categories, or clusters. In this study, participants were prompted or cued to name items from the same conceptual category to increase clustering.

Control strategies are strategies such as rehearsal, semantic, mnemonic, or stories that increase the organization of information in order to increase recall. In the present study, the affect on recall of two control strategies, clustered encoding and semantic encoding, was assessed.

Educable mental handicap (EMH) is defined by Rule 6A-6.03411 of the Florida Administrative Code and the Florida State Plan as (a) a general measured level of intellectual functioning two or more standard deviations below the mean and generally falling between two and three standard deviations below the mean, (b) the assessed level of adaptive behavior below that of other students of the same age and socio-cultural group, and (c) the demonstrated subaverage level of performance in academic, preacademic, or developmental achievement. In the present study, participants were considered to be educable mentally handicapped if they were classified as EMH within their respective school district and had an IQ score of 59 through 73. The upper limit of 73 was used to account for the possibility of a plus or minus three standard error of measurement in the intelligence test score.

Effortful processing is the use of voluntary, intentional effort to encode information. These efforts may include the use of such techniques as rehearsal, imagery, or elaboration and may be affected by characteristics of the individual. In the present study, effortful processing was assessed by recall for item information.

Encoding is the process by which certain aspects or features of a stimulus establish an internal representation of the event for storage and retrieval. In the present study, nonsemantic, semantic, and clustered conditions were used to encode information.

Free-recall procedure is a procedure in which subjects are asked to recall stimuli in any order.

Immediate recall is the ability to remember just-presented stimuli. In the present study immediate recall was assessed by requesting participants to name pictured items without delay following picture presentation.

Long-term memory provides storage for vast quantities of information that is remembered but not currently needed or active. The term secondary memory, currently preferred by behavioral psychologist, is used in the present study to describe this memory store. Secondary memory was assessed by 24-hour delayed recall in the present study.

Nonsemantic encoding is the failure to use previously known information to give meaning to and increase memory for a new event or stimuli. For the present study, nonsemantic encoding was cued by asking the participant to provide the

name of a pictured item without prompting additional information about the item.

Peer without mental retardation of similar chronological age is, for the purpose of this study, defined as a student age 10 through 15 who is not receiving special education services and whose Comprehensive Test of Basic Skills (CTBS) scores indicate functioning within the grade level average of students taking the test in this district.

Primary memory, also known as short-term memory, is a part of memory processing that is limited in size. New incoming information will displace the current contents of this memory store.

Recall is remembering stimuli from prior presentations. Recall requires memory to be searched with prior context as a referent point and explicitly demands recovery of connection between items and context. Listing previously presented words and fill-in-the-blank tests are examples of tests of recall. In the present study, recall was assessed by asking the participants to name previously seen pictures.

Relocation procedure is a procedure in which subjects are asked to recall the location of previously seen stimuli. This procedure is a measure of memory for spatial location. In the present study, placing pictures on their original location on a page was used to test relocation ability.

Retention interval is a measure of the amount of time information is held in either primary or secondary memory

storage. In the present study, both immediate and secondary retention intervals were assessed.

Secondary memory is a vast memory storage not dependent on ongoing activity for maintaining ability to remember. This memory store may be referred to as long-term memory.

Semantic encoding is the use of previously known information not associated with any specific event or stimuli to give meaning to and increase understanding and memory for a new event or stimuli. In the present study, semantic encoding was cued by requesting participants to relate interesting information about a picture being shown.

Short-term memory, the second memory store in the modal model of information processing, receives analyzed information from sensory memory and provides a small, limited storage where information is held for processing. Short-term memory is sometimes known as active or working memory; however, the term primary memory is preferred.

Trainable mental handicap (TMH) is defined by Rule 6A-6.03411 of the Florida Administrative Code and the Florida State Plan as (a) a general measured level of intellectual functioning two or more standard deviations below the mean and generally falling between three and five standard deviations below the mean, (b) the assessed level of adaptive behavior below that of other students of the same age and socio-cultural group, and (c) the demonstrated subaverage level of performance in academic, preacademic, or developmental achievement. In the present study,

participants were considered to be trainable mentally handicapped if they were classified as TMH by the school district and had an IQ score of 30 through 55.

Delimitations of the Study

This study was delimited by geographical restrictions, subject selection, and the scope of measurement procedures. Students from one school district, Pinellas County, a large district located in west central Florida, were included. Participants were students aged 10 through 15 classified as EMH, TMH, or peers without mental retardation with similar chronological ages. Classification of retardation and IQ scores available from the district were accepted. Etiology of the mental retardation was not considered. Students with sensory impairments were not included, and consideration was not given to sex or socioeconomic status of the participants.

Additionally, the study was delimited by the procedure used to measure the dependent variables. A picture recall and relocation task was used to measure recall and relocation ability based on procedures used in previous investigations of automatic and effortful memory processing by persons with mental retardation (Ellis et al., 1987; Ellis et al., 1989a; Katz, 1987).

Limitations of the Study

Generalization of the results of this study are limited by subject selection. Participants were randomly selected for participation from among those meeting the age and

developmental level criteria available from the participating school district. A bias, however, may have existed in the receipt of parental consent to participate. Participants were randomly assigned to experimental groups.

Summary and Overview of Remaining Chapters

The purpose of this study was to determine if the ability of students with and without mental retardation to recall prior stimuli supports Hasher and Zacks's theory of automaticity. The memory functioning of students of three developmental levels was explored. Although persons with mental retardation are reportedly deficient in the structural features of memory processes as well as the efficient and spontaneous use of control procedures, it was hypothesized by Hasher and Zacks (1979, 1984) that information that is automatically processed will not be sensitive to these developmental differences. Therefore, automatically processed information will be recalled equally well by persons at various developmental levels. An extension of this hypothesis is that information that requires effortful processing will be recalled differentially, dependent on developmental level. A better understanding of memory processing for students with and without mental retardation will aid in structuring learning conditions and in increasing instructional effectiveness.

In Chapter 2, a conceptual framework is considered in which three theories of information processing are presented: the structural or modal model, the use of

organizational or control processing strategies, and the level of processing approach. Hasher and Zacks's theory of effortful and automatic processing is reviewed. Additionally, an analysis of literature relating the application of these theories to persons with mental retardation is included. In Chapter 3, the hypotheses are stated and the methodology for implementation of the study is discussed. The presentation and results of the statistical analysis are included in Chapter 4. Chapter 5 consists of a discussion of the results in terms of support for information-processing theories and significance for educational decision making.

CHAPTER 2
REVIEW OF LITERATURE

Information-processing theories have developed to explain how information is acquired, held in storage, and recalled when needed. To establish a foundation for understanding memory processing, this chapter begins with a review of Hasher and Zacks' (1979, 1984) theory of automaticity and three theoretical approaches to memory processing: the structure of memory, the level-of-processing approach, and the use of memory strategies. The chapter concludes with a review of studies applying these theories to persons with mental retardation.

Theory of Automaticity

The theoretical model developed by Hasher and Zacks (1979) is based on two types of information processing: automatic and effortful. With automatic processing, information is acquired incidentally, without attention or awareness. Automatic processing requires minimal cognitive energy, is rapid, makes few demands on attention, and is not sensitive to individual characteristics. A process is defined as automatic if it can be executed even though cognitive resources are diverted elsewhere (Merrill, 1992).

Strategic processes are intentionally used to encode information with effortful processing. Effortful

information processing is slow, sequential, attention demanding, and subject controlled; further, may be affected by such individual variables as IQ, instructions, and motivation (Schneider & Shiffrin, 1977). According to this theoretical model, some stimuli require effortful processing to be encoded into memory. Other stimuli, including frequency of occurrence and spatial location, require only automatic processing to be integrated into memory systems and can be as successfully encoded by persons with or without mental retardation (Hasher & Zacks, 1979, 1984; Katz, 1987).

Schneider and Shiffrin (1977) hypothesized that new learning requires controlled processing while well-learned sequences become automatic. Hasher and Zacks (1979) incorporated this interpretation into their explanation of the two sources of automatic processes. First, automatic processes may be genetically determined and vary minimally with age, intelligence, culture, education, or early experience. The second source of automatic processes, according to Hasher and Zacks, is extended practice. Automatic and effortful processing, therefore, work simultaneously. Memory performance is dependent not only on what the person does but also on what the person already knows.

Researchers of incidental learning have found that memory that does not depend on effortful, strategic processing is developmentally insensitive (Merrill, 1992)

although the ability to focus voluntarily on task-relevant information may not develop until early adolescence and may be further delayed for persons with mental retardation (Brown, 1974). Merrill (1992) reported that encoding differences between persons with and without mental retardation may be due to (a) deficits in effortful but not automatic processing, (b) differences in both automatic and effortful processing, or (c) differences in processing resources that may vary with developmental level. Performance differences occur under task conditions that require the active use of semantic information or other techniques requiring cognitive effort (Brown, 1974; Merrill, 1990).

Greene (1986) reviewed the efforts of researchers who investigated the hypothesis that frequency of occurrence is encoded automatically. According to Greene, a number of researchers have demonstrated that subjects who know they will be tested for frequency information do no better than those who are told to expect a free-recall or an unspecified memory test. Thus, support was offered for automatic encoding of this variable. Katz (1987) examined prior research on the automaticity hypothesis and memory for spatial location. Some researchers have reported finding no individual differences in automatic processing of location; other researchers have found age-related differences. Katz presumably agreed with the view of Ellis et al. (1987) that these differences may not reflect differences in location

memory per se "but rather reflect the influence of developmentally sensitive task-related variables on the criterion test" (p. 22). To minimize the possibility of interference with automatic processing in memory tests, Ellis et al. (1987) made the following recommendations: Task-related tests should include (a) minimal opportunities for effortful or strategic processing, (b) instructions and requirements equally understood by all subjects, (c) location cues clearly and equally differentiated, and (d) item information that is encoded equally well by all subjects.

The significance of studying the theory of automaticity with persons with mental retardation is twofold. First, deficits in automatic processing may affect memory directly and compromise the ability to discriminate among stimulus events. Additionally, automatic processes may serve as building blocks without which the development of effortful processes is precluded (Katz, 1987). Katz went further to assert that if information that is processed automatically by nonretarded persons is processed effortfully by retarded persons, limited attentional resources are consumed "leaving little for the operation of strategic processes" (p. 49). Belmont and Mitchell (1987) agreed that deficient fundamental processing may preclude the efficient application of any memory strategies. Therefore, according to Belmont and Mitchell, if fundamental (automatic) processing deficits exist, "the possibility of deficiencies

at the next higher level (strategies) would seem to be largely irrelevant" (p. 95).

Researchers have relied on the structural, level-of-processing, and strategic approaches to explain memory functioning. Each of these theoretical approaches will now be reviewed. How these three approaches relate to the theory of automaticity, and how mental retardation has been interpreted within each approach is emphasized.

Structure of Memory

The structural features of memory refer to those aspects of the memory system which are not programmable and cannot be varied or changed (Brown, 1974). Starting in the 1950s, cognitive psychologists borrowed from the explanations of electronic processing of information to hypothesize that memory is made up of three discrete memory stores: sensory memory, short-term memory, and long-term memory. This approach, which is known as the modal model, focuses on how information is obtained and transferred among the memory stores as it is progressively incorporated deeper within the memory system.

Katims (1987a) explained that the structure of memory approach does not necessarily refer to the physiological structure of the brain; it refers to structural features or limitations in the sense of rapid decay of information, lack of flow of information among the various stores, or the inability to encode stimuli for retrieval. According to the structural approach, sensory memory provides a momentary

record of raw, unanalyzed events. Short-term memory provides a small repository where information is held by rehearsal techniques while being processed. Long-term memory provides permanent storage for unlimited quantities of information while it is not being used (Schwartz & Reisberg, 1991).

In the modal model, short-term and long-term memory are different memory mechanisms. Short-term memory is small, of a fixed size (holding approximately seven items), is easily accessed by simple attention, and is occupied by whatever entered the most recently. Long-term memory is accessed when information is attended to and contemplated. The capacity and stability of storage increases as information flows from primary, or short-term, to secondary, or long-term, memory (Dugas, 1976). The organization of information can increase the amount of information that can be held in short-term memory. However, as the size of memory chunks increases, the number of chunks that can be held in short-term memory decreases (Schwartz & Reisberg, 1991; Sitko & Semmel, 1972).

Support for the modal model is provided by research into free-recall performance. A U-shaped serial-position curve has consistently resulted from these experiments and is indicative of high recall for primacy and recency events and low recall for items presented in intermediate positions (Schwartz & Reisberg, 1991). Recency events held in short-term memory are those events experienced the most recently.

Primacy events, those initially experienced, are held in long-term memory as they received more in-depth processing. In addition, Paivio and Begg (1981) reported modality differences for recency items; recall is better when items are presented auditorially than when the presentation is visual. Implications from this line of research, according to Paivio and Begg, are that one is likely to remember what one has just heard better than what one has just read. That modality difference may not hold true for primacy events, however.

Although the modal model provides a basis for the understanding of memory functioning, the model has been criticized for failure to (a) provide an explanation for continuity in the flow of information among the memory stores (Brown, 1974), (b) consider the strategies and activities of the subject (Brown, 1974; Schwartz & Reisberg, 1991), or (c) adequately explain recalling of previously learned material in a specific order (Schwartz & Reisberg, 1991). Schwartz and Reisberg (1991) illustrated this last phenomenon, termed long-term recency effect, with subjects who recalled the American presidents in order in a free-recall procedure.

Structure of Memory and Mental Retardation

Both short-term and long-term memory deficiencies have been documented to occur in persons with mental retardation. However, not all research findings are consistent. Brown (1974) reported that persons with mental retardation are

customarily described as deficient in short-term memory but not long-term memory although it is unclear whether the acknowledged deficiencies reflect a structural deficiency or a lack of strategy application. Equal recall of recency items by persons with and without mental retardation on serial-recall tests have led researchers to conclude that there is no difference in primary or short-term memory. Turnure (1991) completed a review of long-term memory and mental retardation and concluded that while data on long-term memory is inconclusive, evidence is accumulating that the long-term memory capacity of persons with mild mental retardation functions within normal ranges on a variety of tasks.

To apply the modal model to persons with mental retardation, it is necessary to interpret these findings in terms of structural versus strategic deficiencies. Katims (1987a) confirmed that evidence supports IQ-related individual differences in memory performance as a result of nonstrategic processes. For persons with mental retardation, the stimulus trace may be both shortened in duration and lessened in intensity resulting in a failure to learn and remember as well, given the same stimulation or effort (Katims, 1987a). Ellis (1970) acknowledged that persons with mental retardation may suffer also from rehearsal deficits as determined by a failure to profit from increased exposure time on tasks.

Developmental theorists contend that short-term memory deficits are not structural problems but deficiencies in the spontaneous use of strategic devices that limit access to long-term memory stores (Butterfield, Wambold, & Belmont, 1973). Overall memory performance differences have been attributed to deficits in rehearsal, although Hale and Borkowski (1991) questioned this view. According to Hale and Borkowski, "it is unclear whether differences in primary memory in mentally retarded individuals are attributable to structural deficits, rate of forgetting, or processing efficiency" (p. 514). Brown (1974) asserted that developmentally related limitations to structural capacity may set limits to the extent to which strategies can be trained, and these limitations may restrict the ability to generalize strategy use.

Structure of Memory and Automaticity

Intelligence-related differences in recall have been noted when strategic processes were not involved. Ellis et al. (1985) provided evidence that persons with mental retardation experience automatic processing deficits. These researchers found that students with mental retardation encoded fewer items on a test of automatic encoding but, once encoded, stimulus durability was unrelated to IQ. These authors favored an automatic processing interpretation of intellectual differences, called for additional research in this area, and invited reconsideration of the idea that

the relationship between intelligence and memory was due to effortful processing alone.

A shift in investigations from structural memory capacities to investigations of processing and strategic behaviors resulted from evidence of rehearsal deficits that affect how information is acted upon in short-term storage. Additional focus was provided to ways in which strategic deficits can be remediated with instruction and support. The essential difference in structural and control failures, according to Katims (1987a), is the susceptibility of the deficit to training.

Level of Processing

The level-of-processing approach maintains that deep processing, thinking about the meaning of stimuli, is the best way to establish memory. This approach preserves the central theme of the modal model; memory improves as information is processed. Focus moves from the structural features of memory, however, to processing, or analysis, of the information. Thus, the determinants of memory shift from the physical features of the information to its semantic features and the strategic behaviors employed by the subject (Lupart & Mulcahy, 1979).

Memory is viewed as on a continuum by the level-of-processing approach. The terms primary and secondary memory are preferred for categorizing memory functions as the terms short-term and long-term memory are seen as providing a misleading distinction about duration of processing time

(Brown, 1974; Schultz, 1983; Schwartz & Reisberg, 1991). Emphasis is given to the qualitative, as opposed to quantitative, aspects of analysis performed on the stimuli. Primary and secondary memory are not seen as separate and discrete memory stores but provide for a seamless flow of information as deeper processing occurs. The strength of the memory trace is determined by the dimensions along which the stimulus is encoded (Craik & Tulving, 1975). The more elaborately information is analyzed and encoded, the more durable the memory trace (Schultz, 1983). Concerns with this theory have been noted by researchers, however, in defining and measuring depth of processing and in accounting for other strategies a person may use to enhance memory (Schwartz & Reisberg, 1991).

Some researchers contend that elaborative processing is yet another approach to information processing while other researchers have argued that elaboration is not a separate principle from processing depth: elaboration simply involves deeper processing (Schwartz & Reisberg, 1991). Elaborative processing involves thinking about the multiple aspects of an event's meaning. In elaborative processing, something is added to what is being learned in order to make it more meaningful (Scruggs & Laufenberg, 1986). More elaborative or richer memory strategies make connections between what is learned and what is known. These connections aid in deeper processing and enhances memory. Therefore, with the elaborative approach, the depth to which

an individual is able to process information is dependent on the expertise, prior knowledge, and expectations the individual brings to the situation (Schwartz & Reisberg, 1991; Scruggs & Laufenberg, 1986).

Level of Processing and Mental Retardation

Persons with mental retardation may experience both mediational and production deficits which affect the level to which information is processed. Mediational deficits exist when a person is unable to employ potential mediators, integrate more than one dimension from stimuli, or consolidate new information with previously known information in problem solving situations. Production deficits may delay the ability to select and attend to relevant aspects of stimuli (Brown, 1974). Schultz (1983) suggested that persons with mental retardation may be capable of achieving shallow encoding as well as persons without retardation, but they may have difficulty in achieving deep encoding. Schwartz and Reisberg (1991) attributed this difficulty to either a lack of relevancy of the memory test or a reduced amount of prior knowledge (a deficient schematic network) the person brings to the learning situation.

Level of Processing and Automaticity

According to the level-of-processing approach, incoming information is subjected to various levels of analysis. The strength and durability of memory is positively related to the degree to which the stimuli has been elaborated at

encoding (Craik & Lockhart, 1972; Craik & Tulving, 1975). Craik and Lockhart (1972) minimized the distinction between incidental and intentional processing and argued that it is the level of processing that predicts future memory performance. Schultz (1983) suggested that incidental memory performance increases as a function of encoding processing depth. Stimuli processed at a deep semantic level will result in a more persistent memory trace.

Mar and Glidden (1977) reported that several stimuli attributes may determine the depth to which the stimuli is processed. Preliminary, or automatic, encoding involves physical features of the stimuli while deeper, effortful processing involves semantic analysis. Intention to memorize is critical in memory performance. Mar and Glidden acknowledged that the failure to encode beyond preliminary stages may contribute to deficits in associative clustering and memory processing.

Strategy Use

Mnemonic strategies that increase the organization and semantic content of information improve memory for to-be-remembered material (Paivio & Begg, 1981; Schwartz & Reisberg, 1991; Sitko & Semmel, 1972). Rehearsal, chunking, grouping and other organizational devices, and encoding by transforming from one stimulus code to another (e.g., from visual to auditory stimuli) represent types of strategy use. According to the general strategy use hypothesis, performance is increased to the maximum possible for a task

when an optimum strategy is properly executed. A properly executed strategy is one that guides the construction of an effective sequence of tactics (Belmont & Mitchell, 1987). Active strategy use requires the ability and intention to plan one's performance in advance. General skills are needed to engage voluntarily in mnemonic activity; specific skills are required to carry out specific mediational routines (Brown, 1974).

Criticisms of the strategy use approach as a comprehensive explanation of learning and memory have centered on the inability to define consistently and measure strategy use, the inconsistent application of the construct, and the view by some researchers that strategy use offers a total, rather than partial, theoretical explanation for learning and memory deficiencies (Belmont & Mitchell, 1987).

Strategy Use and Mental Retardation

Persons with mental retardation have been shown to exhibit both qualitative and quantitative limitations in employing rehearsal, clustering, and other organizational strategies to aid in memory and learning (Brown, 1974; Gerjuoy & Spitz, 1966). Deficits have been attributed to (a) failure to employ strategies spontaneously, (b) the application of strategies in a way different from their original intent, or (c) an unawareness of the need for strategic intervention (August, 1980). The active use of rehearsal strategies may depend on the attributes of the person, the instructions received, the perception of task

difficulty, or the particular task or situation (Belmont & Mitchell, 1987; Brown, 1974; Ellis, 1970).

Limited success has been shown in increasing recall abilities of persons with mental retardation through the use of categorical lists, temporal blocking, generation of mediating sentences for word triads, and rehearsal training (Glidden et al., 1983). Organizing information by recurring redundant patternings can reduce information processing demands and decrease memory load. Persons with mental retardation are less efficient at recognizing and using organizational patterns, however, unless redundancy is high (Spitz, 1966) or they are given explicit instructions to attend to conceptual relationships (August, 1980). Brown (1974) observed that failure to employ rehearsal strategies, even after training to do so, may be a function of capacity limitations.

Gerjuoy and Spitz (1966) explored the efficacy of training programs to increase the ability to organize and cluster input. They found that this training did facilitate immediate recall. The ability to generalize this organization to new tasks, the long-term effectiveness of such training, and the efficiency of rehearsal strategies in enhancing elaborative processing appear limited, however (Brown, 1974; Engle & Nagle, 1979; Glidden et al., 1983). The lack of ability to retain and transfer strategy use to a novel situation has been cited as a defining characteristic of mental retardation (Belmont & Mitchell, 1987).

Strategy Use and Automaticity

Although much real-world information is automatically encoded and depends on free-recall retrieval, focusing attention on the use of control processes has highlighted teaching persons with mental retardation to produce and spontaneously use strategies to decrease performance deficiencies (Glidden et al., 1983). Nonetheless, strategy instruction may decrease future occurrences of deficits in incidental learning (Dugas, 1976; Fox & Rotatori, 1979). The inability to use organizational strategies may result in an inability to screen out irrelevant information or attend to appropriate mediators in novel situations (Bilsky, Whittemore, & Walker, 1982).

Application of Memory Models

In this part of the chapter, literature relevant to the study of the effect of encoding condition on recall by persons with mental retardation is reviewed. Selection of studies for the review was based on both the construct and the subjects investigated. A study had to meet the following criteria to be included in the review.

1. The study had to include a test of memory functioning. Tests were included for both short-term and long-term measures of both recall and recognition memory.

2. The subjects must have been thoroughly described and some of the participants had to include persons with mental retardation, between the ages of 10 and 21. Studies

that involved participants exclusively who were younger than 10 or older than 21 were not included.

3. The study must have been empirical in nature with the intervention or tests used described in sufficient detail to permit replication.

4. The study must have been cited in the literature since 1967.

A total of 138 studies were located for this review. The analysis of the findings of these studies is organized to reflect the application of encoding conditions and the theories of memory processing to persons with mental retardation. Therefore, the findings of the studies are synthesized by the following areas: (a) encoding condition, (b) developmental trends, (c) structural processes, and (d) strategic processes.

Encoding Condition

Encoding condition refers to the establishment of an internal representation of a stimulus for storage and retrieval. Several investigators have studied factors that influence encoding and the effect of encoding condition on recall. Results of investigations of the effect of encoding condition on memory of students with mental retardation are organized around tests of encoding condition and influences to information encoding.

Tests of encoding condition. From a study that included 30 students with mild mental retardation (average IQ 62.5) and 30 nonretarded peers, Ellis et al. (1985) reported that

persons with mental retardation were encoding-deficient because fewer items were encoded by the students with mental retardation. Once encoded, item durability was unrelated to IQ, however. Ellis et al. further determined that students without retardation were able to encode faces more accurately than students with retardation. The researchers had predicted that this variable would be encoded automatically and, therefore, encoded equally well by both persons with and without retardation. In addition, those students who claimed to use strategies had more accurate recall. These results favor a general interpretation that persons with mental retardation experience a difference in automatic processing, according to these authors. Diech (1974) also provided evidence for deficits in automatic processing and incidental learning in students with mental retardation following research involving 18 students with an average IQ of 51.0 and 18 kindergarten students. Diech pointed out, however, that it was important to note that the students with retardation did experience some incidental learning.

In contrast to the findings of Diech, Schultz (1983), who studied 12 students classified as educable mentally retarded whose average IQ was 65 and 12 children without mental retardation, affirmed that the students with mental retardation who received an unexpected recognition test retained information as well as peers without retardation. No deficits in incidental learning were apparent. Hillman

(1972) used a total of 90 students between the ages of 9 and 13 to study the effects of question type and position on the learning among children with mental retardation. No differences between groups matched for mental age on an incidental criterion test were found. Song and Song (1969) evaluated the effectiveness of discriminating reading skills based on the visual memory ability of 26 adolescents classified as high readers (average IQ of 60) and 28 adolescents classified as low readers (average IQ of 59). Reproducing designs from memory, an incidentally coded event, was determined to be one discriminator of reading ability. Reading achievement of persons with mental retardation was not related as much to their ability to perceive but to their ability to remember what was perceived.

In an investigation of the level of processing framework, Lupart and Mulcahy (1979) investigated incidental and intentional learning of 42 students classified as EMH and 42 nonretarded students from the forth, fifth, and sixth grades. Only partial support was expressed for the hypothesis that recall performance was positively related to depth of processing. A significant difference in recall was noted between incidental and planned intentional conditions but not between incidental and intentional conditions. Depth of processing did influence the durability of memory.

<u>Factors influencing encoding</u>. Incidental learning was influenced by prior instructions on categorization in a

study by Fox and Rotatori (1979). Dugas (1976) included 40 institutionalized students with mental retardation in an investigation of recall differences of familiar and control stimuli due to subject-paced and experimenter-paced presentations. Recall followed the classic, bowed serial-position curve; recall differences due to stimulus presentation and pretraining were restricted to primacy effects. Subject-paced presentation also affected primacy effects for students without mental retardation. Familiarization training to acquaint subjects with the stimuli did not affect primacy effects for students with mental retardation but did for those without retardation. The combined results of this study support the hypothesis of the positive effect of rehearsal on both encoding and recall of primacy events.

Mar and Glidden (1977) used free- and cued-recall tasks to study the effect of semantic and acoustic encoding on seven encoding groups. Each group consisted of 14 students and each group had a mean IQ of 60. Both semantic encoding and semantic retrieval cues were needed to produce maximum recall. Semantic cues did not influence free recall patterns. Therefore, the authors concluded that persons with mental retardation may not be able to use elaborative encoding processes or retrieve items once elaboration has been used.

Bray and Ferguson (1976) studied the effect of cues to forget previously presented information with students with

mental retardation. In experiment I, 16 students with an average IQ of 66.8 and average age of 9.8 were compared with 22 nonretarded students with an average age of 7.4. In a replication of experiment I, a second group of 16 students, average IQ of 70.6 and average age of 10.7, were compared with 24 nonretarded students with an average age of 6.9. Passively acquired information was easily lost. This passively acquired information interfered only minimally with recall of actively acquired information. Bray, Turner, and Hersh (1985) also investigated the developmental course of selective remembering. Forty-eight students, 16 from each of three age groups, were studied. Students 11 years of age without mental retardation were able to use forget cues, but those of similar ages with retardation (mean IQ of 69.3) were not able to take advantage of such cues. Two additional groups of students with mental retardation were studied by these researchers. Those with an average age of 15 and those with an average age of 18 were not able to eliminate interference from to-be-forgotten items although this skill was available to study participants of similar ages without retardation.

Differences in serial position effects following fixed-set or variable-set procedures led Phillips and Nettelbeck (1984) to conclude that the encoding procedures used affect the performance of children and persons with mental retardation more than encoding procedures affect nonretarded adults. Ten students with retardation (average IQ of 67),

10 nonretarded students from the third and forth grades, and 10 college students were included in this investigation. Additionally, the type of stimulus used had a profound influence on the encoding scan rates of students with mental retardation in a test of high-speed memory scanning conducted by Maisto and Jerome (1977). Six students without mental retardation and six students with mild retardation (average IQ 72.4) were involved in this investigation.

Merrill (1992) examined differences in the speed of encoding of 15 students with an average IQ of 60.2 and 15 college undergraduates. Merrill determined that differences in processing speed resulted from encoding that required attentional resources. The size of memory load influenced encoding times for all subjects. Decision processes were executed more efficiently when resources were allocated to their execution. These findings do not support the assumption that familiar stimuli are encoded automatically. Merrill concluded that there may be memory processes that can be executed without attentional resources if necessary, but are performed better and faster when resources are allocated.

In support of theories of automatic processing, memory for spatial location was unrelated to age, intelligence, or type of instruction in a study by Ellis et al. (1989a). A total of 28 students from the second grade, sixth grade, college students, and students with mental retardation (average IQ of 62.9, average age of 16.41) were included by

Ellis. The inability to relocate items was not inherent of either low IQ or Down syndrome. Both age and intellectual trends were shown in the number of items recalled, however.

Summary. Studies of the effects of encoding conditions on recall have achieved mixed results. Hillman (1972) and Schultz (1983) offered support for Hasher and Zacks (1979, 1984) theory of automatic and effortful processing when their research produced no deficits in incidental processing of information by persons with mental retardation. Automatic encoding deficiencies were acknowledged by Diech (1974) and Ellis et al. (1985).

Possible explanations for these discrepant findings were offered by several researchers who demonstrated that encoding of information and therefore, incidental learning, may be influenced by prior instruction (Dugas, 1976; Fox & Rotatori, 1979), the procedures used (Maisto & Jerome, 1977; Phillips & Nettelbeck, 1984), the size of the memory load (Merrill, 1992), the type of information to be encoded (Ellis et al., 1989a), and the ability to benefit from cues (Bray et al., 1985; Mar & Glidden, 1977).

In the present study, the effect of encoding conditions on recall was investigated. Both immediate recall and durability of memory were used to assess if differences exists across developmental levels with actively and passively acquired information. Differences in recall and retention in item identification and item relocation would support the theory of automaticity because evidence would be

provided that these two attributes are processed differently. Differences in locating recalled and unrecalled items would suggest further independent processing of these two attributes and provide additional support for the theory of automaticity.

Developmental Trends

Differences in recall abilities based on developmental levels have been investigated by several researchers. Researchers have compared the memory performance and use of memory strategies by students with different classifications of mental retardation with students matched for mental age, or nonretarded peers of similar chronological ages.

Trends in memory processing. Calfee (1969) investigated short-term retention as a function of memory load with groups of students classified as moderately, severely, and educable mentally retarded. Nine students with an average IQ of 65, 12 students with an average IQ of 44, and 10 with an average IQ of 37 were studied. Recall performance and ability to encode and organize information decreased with age and IQ while forgetting increased with age and IQ. Recognition memory remained fairly constant.

Baumeister (1974) analyzed developmental trends across a wide variety of materials and modalities on tests of serial memory span thresholds with 15 students from each of three groups (second graders, sixth graders, and students with mental retardation with an average IQ of 71.7 and an average age of 11.0). Lamberts (1979) showed that the

memory spans of adolescents with mental retardation (35 students, average IQ of 37.8, average age 14.58) were comparable to the memory span of students matched for mental age (25 students from kindergarten and nursery school, average age 4.42) when the stimuli were not abstract. The students with mental retardation did less well when the stimuli were linguistic. The strong age effect supports the hypotheses of the growth of memory span with age (Lamberts, 1979). McLaughlin, Stephens, and Moore (1971) used a visual memory task (reconstruction of geometric shapes) to evaluate reconstructive memory systems. Forty-eight students with an average IQ of 90-110 and 48 with an average IQ of 50-75 were studied. Both groups included students from age 8 to 18. As the age of the subject increased, memory drawings more closely resembled the original configuration. These researchers suggested that reconstructive memory systems are developed prior to the development of evocative systems.

Stephens, Anderson, and Garrison (1971) observed that the performance of 35 nonretarded study participants matched for both mental age and chronological age exceeded the performance of students with mental retardation on a seriation task (reproducing pictures of stimuli arranged by decreasing size). Improvement following instruction did not occur in the youngest students with mental retardation, leading the authors to conclude that seriation schema were incompletely developed. Improvements by subjects without

retardation at a 6-month follow-up test was indicative of the establishment of a seriation schema.

Brown, Campione, and Barclay (1978) trained two groups of students classified as EMH on anticipation and rehearsal strategies that included a self-checking component. Group one included 21 students, aged 10, with an average IQ of 70. Participants from group two were 13 years of age and also had an average IQ of 70. Compared to a control group, students trained in self-checking routines took more time studying, recalled more from a prose passage, and recalled information more clearly related to thematic constructs from the passage. Brown and her colleagues pointed out that these patterns are characteristically seen in students developmentally more advanced. Lower-functioning students (mean mental age of 6) showed no effects of the training at the 1 year follow-up. More advanced students (mean mental age of 8) both maintained original rote recall ability and generalized the ability to recall the gist of the prose passage to novel situations.

<u>Trends in strategic skills</u>. In an investigation of the relationship of mental age to retentional capacities and the use of retention strategies, MaBane (1976) observed that both retention capacity and strategy use were directly related to level of intelligence. The results of this study, which included a total of 18 students of two levels of retardation (group one mean IQ 74, group two mean IQ of 50), reflect short-term memory capacity constraints on the

use of rehearsal techniques related to developmental level. Students with moderate and severe retardation did not benefit from external organization (categorical clusters) although other researchers had found this technique to be successful in aiding students with EMH to increase recall (Burger & Erber, 1976). These researchers, who observed 16 students with an average IQ of 39.12, hypothesized that lower functioning students were not able to understand organizational or categorical labels.

Swanson (1977) used both pictures and actual objects for a serial recognition tests with 10 students classified as learning disabled (mean IQ 100.3) and 10 students classified as EMH (mean IQ 73.3). The students classified as learning disabled were able to make use of three-dimensional material while the EMH students could not effectively process the same concrete material. No differences were seen in recognition memory for pictures.

Sugden (1978) reported that developmental trends in the use of rehearsal strategies apparent in 15 nonretarded students from each of three grade levels (6th, 9th, and 12th grades) were almost totally absent in a similar number of students with mental retardation matched for chronological ages. Lupart and Mulcahy (1979), who studied a total of 84 students, contended that the ability to increase memory performance through adopting memory strategies may be more related to mental age than to IQ. No significant differences in gains in recall across incidental,

intentional, and planned-intentional conditions were noted by these researchers. Engle and Nagle (1979) identified semantic processing deficits with mildly retarded students 13 years of age but not with those 10 years old. They determined that to be able to use semantic encoding strategies, the student must be able to use externally provided prompts and learn to provide prompts for internal mediation. In their study, developmental trends were shown in these abilities. The IQ's of study participants ranged from 50 to 75. Engle and Nagle concluded that the semantic network is not sufficiently developed by age 10 to allow categorical decisions to facilitate recall. This hypotheses is supported Reichart, Cody, and Borkowski (1975), who studied 44 students with mental retardation whose IQ's ranged from 30 to 70. They found that only those students with an IQ greater than 50 were able to acquire and transfer strategy use.

By contrast, even the youngest students in a study by Becker and Morrison (1978) had increased memory performance when encouraged to use categorization skills. Measures of clustering were studied with 57 nonmentally retarded students, 87 students classified as learning disabled, and 91 students classified as EMH. Students with lower mental ages needed assistance in organizing materials while students with higher mental ages perform better when allowed to structure their own organization.

Summary. Developmental trends in recall and recognition memory have not been produced consistently; however, researchers generally have described the ability to organize, encode, and retrieve information as related to both age and developmental level (Calfee, 1969; McBane, 1976; Swanson, 1977). Developmental trends in memory performance may be the effect of the modalities and materials employed (Baumeister, 1974; Lamberts, 1979; McLaughlin et al., 1971) or the inadequate use of strategies (Engle & Nagle, 1979; Lupart & Mulcahy, 1979; Reichart et al., 1975; Stephens et al., 1971; Sugden, 1978). Evidence of the ability of younger students with mental retardation to benefit from strategy instruction has been inconclusive (Becker & Morrison, 1978; Burger & Erber, 1976).

In the present study, the memory processing of students of three developmental levels was assessed. Of specific interest was the effect on memory of level of retardation under various encoding conditions. If developmental trends were evident in automatically processed information, support would not be shown for the theory of automatic and effortful processing because, according to Hasher and Zacks (1979, 1984), age and ability do not affect the memory of automatically processed information.

Structural Processes

Structural processes describe how information is processed, retained, and flows among the various memory stores. In this section, studies in which researchers

assessed structural processing mechanisms and structural deficits in students with mental retardation are reviewed.

Structural processing. In a classic study of structural versus strategic processing, Glidden and Mar (1977) evaluated the ability of 80 students with and without retardation to retrieve information from storage. Students with retardation (average IQ of 60) retrieved about 60% of the number of items retrieved by those without retardation. This difference in recall rates could not be accounted for solely by the number of items available in storage. It was hypothesized that both accessibility and availability deficits existed.

Persons with and without mental retardation processed auditory and visual information in similar ways, according to Katims (1987b). Twenty-four students with educable mental retardation and 24 similar age peers were studied. Quantitative differences were noted under all three treatment conditions used by this researcher. No differences between auditory and visual memory span for letters resulted when 15 students classified as trainable mentally retarded (IQs ranging from 27 to 55) were tested (Varnhagen, Das, & Varnhagen, 1987). Students with Down syndrome (13 students with IQs from 28 to 45) did not differ from those with other etiologies. In addition, Varnhagen et al. demonstrated that persons with mental retardation have less efficient information processing, faster stimulus decay, and greater stimulus interference on both recall and

recognition tasks. These findings were offered as evidence of structural short-term memory deficits. Reid and Kiernan (1979) also reported modality-related encoding deficiencies when examining the abilities of six students with severe retardation (average IQ of 47) to encode spoken words and manual signs.

Structural deficits. Stratford (1979) determined that test behavior was similar for all three groups studied in a test of discrimination memory as participants from all developmental groups appeared to attempt to rehearse input and not randomize stimuli presented. Study participants included students with Down syndrome (average mental age of 3.8), students with mental retardation with other etiologies (average mental age of 3.4), and nonretarded students (average mental age of 5.7). The author confirmed poor short-term memory existed for size, form, and order for students with mental retardation, both with and without Down syndrome.

Studies of secondary memory deficits have led several researchers to conclude that, for persons with mental retardation, primary memory is intact. Secondary memory deficits may result from deficits in rehearsal strategies that mediate the transfer of information from primary to secondary memory (Ellis et al., 1985). Dugas and Kellas (1974) determined that the 14 students with mental retardation they studied (average IQ of 71.75) were at a distinct disadvantage in the use of primary memory, however.

On an immediate recognition memory test, students with mental retardation had higher average reaction times for retrieving information and for making serial comparisons.

Burack and Zigler (1990) used two tests of intentional memory and one test of incidental learning to investigate differences in the memory functioning of persons with organic and nonorganic retardation. Thirty-five students without retardation (average age 9.34, average IQ of 94.63), 33 students with familial retardation (average age 13.49, average IQ 63.64), and 40 students with organic retardation (average age 15.78, average IQ 59.2) were studied. Results on incidental learning tasks were no different from intentional test results. Etiology should be considered when studying memory processing differences, according to these authors, due to differences in structural systems, differences in utilization of structural capabilities, and differences in task-related motivations. Reichart et al. (1975) provided evidence that strategy use and recall did not differ by etiology when they examined rehearsal strategy use by students whose IQ ranged from 30 to 70.

Engle and Nagle (1979) interpreted the results of a study of encoding strategy use by 42 students with mild retardation (IQ range 50-75) as supportive of deficits in declarative knowledge. Declarative knowledge was defined as the amount and complexity of knowledge existing in long-term memory and the number of associations automatically elicited when an item is presented for memory. Engle and Nagle

described deficits in declarative knowledge as "not quite but almost both structural and strategic" (p. 28). Deficits, according to Engle and Nagle, are not structural or physiological per se, but are based on automatic processing not under conscious control. Strategy use, on the other hand, requires conscious associations. With practice and an increase in the number and richness of available associations, automaticity develops. Ellis et al. (1985) agreed that some nonstrategic tasks may depend on semantic knowledge and, therefore, be sensitive to individual differences. Engle and Nagle (1979) believed that for students classified as EMH to remember as well as nonretarded peers, instructional strategies should focus not only on developing strategic repertoires but also on equating the extent, richness, and automaticity of declarative knowledge. Teaching techniques should be used that enhance the amount of existing knowledge and experiences (Engle & Nagle, 1979).

Glidden and Mar (1977) reported that one aspect of an accessibility deficit in persons with mental retardation involved failure to spontaneously use mnemonic strategies consistent with semantic organization. Glidden et al. (1983) echoed concerns expressed by Engle and Nagle that the use of semantic strategies may be hindered by the lack of comprehension or failure to understand the to-be-remembered information. Glidden and her colleagues used two groups to investigate the efficacy of semantic processing on free

recall. Group one consisted of 48 students with an average IQ of 62.9. Participants from group two contained were 36 students with an average IQ of 68.1. Glidden et al. concluded that the problems linking stimuli may account for developmental delays in recall and comprehension. Additionally, strategy use may increase semantic knowledge on other tasks and thus be more beneficial than rote rehearsal strategies.

Summary. Studies of memory and retrieval led Glidden and Mar (1977) to conclude that both accessibility and availability deficits may exist for persons with mental retardation. Similarity in processing styles between persons with and without retardation was seen by Katims (1987b) and Stratford (1979) although quantitative and modality related differences have been noted as well (Katims, 1987b; Reid & Kiernan, 1979). Some researchers have observed differences in recall ability related to etiology, while no etiology-related differences were identified by other researchers (Burack & Zigler, 1990; Reichart et al., 1975).

Studies of structural processes of memory can provide information concerning deficits in short-term memory, long-term memory, or both. Stratford (1979) explained that, for students with mental retardation, short-term deficits existed in memory for size, form, and order. According to the theory of automaticity, this information should be encoded automatically and not sensitive to developmental

differences. The present study included analysis of short-term and long-term memory of automatically and effortfully processed information to determine if developmental trends occur.

Strategic Processes

Several strategies have been shown to be at least minimally effective in increasing memory processing for persons with mental retardation. In this section, the use of specific task strategies, clustering, and semantic or elaborative strategies are reviewed.

Task-specific strategies. Overlearning, or additional presentations of stimulus materials, was assessed with a group of 36 students classified as educable mentally retarded (average IQ 73.0) and 24 third-grade students matched for mental age (Raskin, 1970). Overlearning was necessary to overcome deficits in long-term perceptual memory for the study participants with mental retardation. Ross and Ross (1978) divided 33 students into three treatment groups to determine the effectiveness of imagery, rote repetition, and control conditions. The groups average IQs were 65.73, 66.27, and 68.36, respectively. Imagery was superior to rote memory training for increasing multiple associate learning. The results of a study by Fox and Rotatori (1979) supported earlier work by Brown (1974) that specific instructions and task-specific strategies should be used with persons with mental retardation to maximize learning.

The positioning of questions in a story strategy affected learning and recall in a study by Hillman (1972) using 90 students aged 9 to 13. Questions which followed presentations of story sections, close temporal proximity between critical information to be learned and questions, and questions of the same type for training and criterion testing were most effective. When Burger and Erber (1976) allowed 16 students with an average IQ of 39.12 to select to-be-remembered items, item preference was more important than practice effects in stimulating learning and recall. Raskin (1969) indicated that prior training may hinder the perception of apparent movement. Training was provided to a total of 30 students. One group ranged in age from 8 to 13 (average IQ 71.8); the age range for group two was 11 to 15 (average IQ 73.6). More experience in training sessions was required by students with retardation to establish enduring perceptual learning.

For students with an IQ of less than 50, a cumulative-rehearsal strategy was most efficient for inducing strategy transfer when Reichart et al. (1975) studied 44 students with IQs ranging from 30 to 70. For higher-functioning students, a cumulative-clustering strategy enhanced learning and transferred to new information for short-term recall, but the use of this strategy dissipated by a 2-week follow-up. Use of a cumulative-rehearsal strategy showed greater consistency in duration patterns over 1-hour, 24-hour, and 2-week follow-up testing. Strategy acquisition and transfer

was limited by mental age as participants with lower IQs did not acquire, transfer, or profit from active rehearsal strategies.

Clustering. Gerjuoy and Spitz (1966) used two experiments to investigate the growth of clustering and free recall as a function of age, intelligence and practice. Two groups of institutionalized students (20 students per group with an average IQ of 72.05 and 52.95, respectively), 19 students matched for mental age (average age 9.81), 14 students matched for chronological age (average age 14.70), and 20 college students were included in the study. Both presenting stimulus words in categories and requesting subjects to recall words in categories increased recall for students with mental retardation. A combination of these procedures produced the greatest increases. In a study of organizational strategies to increase free recall of verbal learning, Sitko and Semmel (1972) observed that 30 students classified as EMH (average IQ 69.9) experienced less clustering and recall on categorical lists and on stimulus lists of highly associative noun pairs than 30 nonretarded peer of similar chronological ages.

Evans (1977) used 24 students from each of three groups to study associative-clustering tendencies. Students from the sixth grade, seventh grade, and those with mental retardation with a mean IQ of 73 comprised the groups. When novelty-condition lists and organized-condition lists were assessed to determine the ability to transfer associative-

clustering techniques, results indicated that recall process factors were similar for students without retardation as for those classified as borderline mentally retarded. Gerjuoy and Alvarez (1969) studied the transfer of clustering techniques from a list presented categorically to a task requiring the recall of randomly presented words with 60 students with an average IQ of 59.4 and 60 nonretarded peers. Both students with and without mental retardation benefitted from external clustering imposed by the examiner. Neither practice nor familiarity with the task increased recall or clustering performance on the randomized list.

Baumeister (1974) illustrated that forced chunking (paired-associate stimuli) increased the serial memory span of 15 students with mental retardation (average IQ 71.7) as well as 15 students each matched for mental and chronological ages. Becker and Morrison (1978) attested that blocking and sorting techniques increased measures of clustering for both students classified as learning disabled as well as those with EMH.

In a study comparing the use of prompts by 56 students with mental retardation (mean IQ 74) and 56 fifth-grade students, August (1980) determined minimum-sort prompts to be as effective as maximum-sort prompts for improving recall and clustering. Minimum cues included instructions to sort words by category. Maximum-sort prompts included training and practice in categorization. As no benefit resulted from explicit instructions in generating organizational schemas,

August emphasized the importance in isolating factors responsible for IQ-related disparities in memory performance.

Semantic and elaborative strategies. Engle and Nagle (1979) compared the techniques of semantic encoding, repetitive rehearsal, and acoustic encoding (thinking of the sound of the word and repeating the initial sound) for increasing the recall of 42 students with IQs ranging from 50 to 75. Free recall was enhanced by the use of semantic encoding on both training and unprompted follow-up word lists. No difference in strategy use was seen on a recall test 7 months later until the semantic strategy was prompted. Following prompts, the semantic group showed greater improvement. Students with mental retardation required additional time to construct rich, more elaborative memory traces when Schultz (1983) compared 12 students with an average IQ of 65 to 12 nonretarded children. As the students classified as EMH were increasingly slower in encoding at progressively deeper processing levels, Schultz asserted that persons with mental retardation either have difficulty in combining information or the interaction between the subject, processing level, and decision time is indicative of short term memory deficits.

Riegel, Taylor, and Danner (1973) used two groups of students classified as EMH to study the effect of mnemonic strategy use on language development. Group one consisted of 29 students with an average IQ of 72.3. Group two had 32

participants with an average IQ of 72.5. Following training to seek and utilize associations between stimuli, no differences were demonstrated between the groups on sorting and recall measures.

Merrill and Bilsky (1990) used subject, verb, and subject-verb cues to encode sentences semantically into memory with 33 students with mild retardation (average IQ 62.9), 33 nonretarded 4th-grade students, and 33 nonretarded 10th graders. All groups showed some advantage to using two-word, subject-verb cues; students with mental retardation showed the smallest recall gains. The ability to utilize holistic representations, therefore, was determined to be a function of both age and intelligence. It was hypothesized that persons with mental retardation may not be able to perceive sentences as a single, integrated unit.

Story strategies were used to increase semantic encoding in two studies by Glidden and Warner (1983, 1985). In the first analysis, 60 students with an average IQ of 66.63 were studied. The second experiment included 24 students with an average IQ of 66.7. Stories generated by the study participants facilitated recall of those students without retardation. This semantic strategy failed to increase the learning and memory of those participants with mental retardation, however, unless order of recall was disregarded. Instructions to recall stimuli in serial order appeared to change how the information was processed. When

order of recall was disregarded, less reliance was made on input organization and flattened serial position curves resulted. Follow-up from both of these studies affirmed that the advantages of semantic story use was maintained over short intervals but faded at longer (8-month) intervals. An added finding of these studies was that, as recall and retention were related to the quality of stories produced, persons with mental retardation seemed to do better when mediators were provided externally. Subject-created stories involved only minimum semantic processing while experimenter-created stories increased retention and immediate recall. Additional training may be needed in story creation and creating meaningful retrieval cues (e.g., story titles) if subject-composed story strategies are used with persons with mental retardation (Glidden et al., 1983).

Summary. Several strategies have been studied with students with mental retardation. Overlearning, imagery, single- and multiple-word cues, rehearsal and clustering, and questioning techniques have been used to increase memory performance (Hillman, 1972; Merrill & Bilsky, 1990; Raskin, 1970; Reichart et al., 1975; Ross & Ross, 1978). Both semantic encoding and story strategies have shown promise for increasing memory through increasing depth of processing (Engle & Nagle, 1979; Glidden & Warner, 1983; 1985) although questions exists concerning the durability of these techniques. Brown (1974) warned that strategy training

should be task specific to be effective for students with mental retardation.

In the present study, the use of semantic and non-semantic encoding, clustering, and clustering-probed recall techniques were investigated on a picture recall and relocation task to determine if these strategies were affected by developmental differences and produce differences in short-term and long-term retention. If no differences were exhibited for recall of location across encoding conditions, support would be evidenced for the theory of automaticity. Hasher and Zacks (1979, 1984) hypothesized that input for spatial location will be automatically processed and, therefore, not sensitive to instructions or intention to process.

CHAPTER 3
METHODS AND PROCEDURES

In this study a picture recall and relocation test was used to assess the effect of encoding condition and developmental level on memory of students with and without mental retardation. Performance on recall and relocation measures was compared across encoding conditions and developmental levels to determine support for the theory of automatic processing as hypothesized by Hasher and Zacks (1979, 1984). Three experimental encoding conditions were used: nonsemantic, semantic, and clustered. Participants of three developmental levels were assessed: educable mentally handicapped (EMH), trainable mentally handicapped (TMH), and peers without mental retardation of similar chronological ages. The recall and relocation tests were completed with each participant with a follow-up test of secondary memory completed approximately 24 hours after the initial testing. This chapter is divided into five sections: Null Hypotheses, Selection and Description of Participants, Research Methods, Procedures, and Data Treatment.

Null Hypotheses

The following null-hypotheses were tested at the .05 level of confidence for each main effect or interaction:

H1 There is no statistically significant difference in the mean number of items recalled following presentation of 50 pictures as a function of (a) three developmental levels of THM, EMH, and peers without retardation of similar chronological ages; (b) three encoding conditions of nonsemantic, semantic, and clustered; or (c) two retention intervals of immediate and 24-hour recall.

H2 There is no statistically significant effect on the mean number of items recalled following presentation of 50 pictures as a function of the two-way or three-way interaction of the (a) three developmental levels of THM, EMH, and peers without retardation of similar chronological ages; (b) three encoding conditions of nonsemantic, semantic, and clustered; and (c) two retention intervals of immediate and 24-hour recall.

H3 There is no statistically significant difference in the mean number of items relocated following presentation of 50 pictures as a function of (a) three developmental levels of THM, EMH, and peers without retardation of similar chronological ages; (b) three encoding conditions of nonsemantic, semantic, and clustered; or (c) two retention intervals of immediate and 24-hour recall.

H4 There is no statistically significant effect on the mean number of items relocated following presentation of 50 pictures as a function of the two-way or three-

way interaction of the (a) three developmental levels of THM, EMH, and peers without retardation of similar chronological ages; (b) three encoding conditions of nonsemantic, semantic, and clustered; and (c) two retention intervals of immediate and 24-hour recall.

Selection and Description of Participants

Participants of this study were 180 students enrolled in a large public school district in west central Florida. In the present study, the memory functioning of adolescents, aged 10 through 15, was assessed to keep with the findings of several researchers that the ability to use control strategies may not develop until early adolescence and may be further delayed for persons with mental retardation (Brown, 1974).

The 180 participants constituted three groups: 60 EMH, 60 TMH, and 60 peers without retardation of similar chronological ages. These groups were developed by (a) development of a pool of potential participants for each developmental level who met the age and IQ or CTBS restrictions and for whom permission to participate had been received, and (b) random selection of 60 participants per group from the pool for each developmental level. Within each group, students were randomly assigned to one of three experimental encoding conditions.

The names of 164 students without mental retardation were made available to the researcher by the district. These students received requests for consent to participate.

From the 103 who furnished parental consent, an available pool of 85 resulted after it was determined that the predefined age and CTBS parameters were met. A random number selection procedure was used to select 60 participants for that developmental level.

The same procedures were followed for the students classified as EMH and TMH. Of the original 139 names of students classified as EMH made available by the district, 75 comprised the available pool of those with parental consent and meeting the age and IQ eligibility criteria. For students classified as TMH, the names of 88 students were made available by the district. An available pool of 73 resulted from which the random selection procedures were used to select the 60 participants.

Classification of the students with mental retardation was based on local district classifications. Participants classified as THM were required to have an IQ score of 30 through 55. Participants classified as EMH were restricted to students with an IQ score of 59 through 73. The participants who were not retarded were required to have scores indicating functioning on grade level on the Comprehensive Test of Basic Skills (CTBS) and not receiving special education services. These restrictions were imposed in order to decrease the possibility of the overlap of IQ scores among the groups. The IQ scores were obtained from psychological records available from the school district

and, for participants classified as EMH or TMH, these scores must have been no more than 4 years old.

Research Methods

Participants were solicited from those enrolled in the cooperating school district who met the age and classification guidelines. Prior to conducting the study, the respective approval of the University of Florida Institutional Review Board and the Director of Planning and Policy for the Pinellas County School District were obtained and are contained in Appendix A. A Parent Informed Consent Document (Appendix B) was sent to each parent and informed consent was obtained for each participant.

Each participant was seen individually. Approximately 30 minutes were required to complete the experiment. A follow-up test probe, which paralleled the original experiment, was conducted approximately 24 hours following initial testing.

The procedures used in this experiment are based on techniques used by Ellis et al. (1987) and Gerjuoy and Spitz (1966). Ellis et al. used recall of picture identification and picture location to test automatic and effortful processing. Gerjuoy and Spitz (1966) studied clustering of nouns to determine the effect of externally provided associative clustering on recall. Pictures were used for the current experiment because the use of written words limits neutrality of the response task with persons with mental disabilities (Lamberts, 1979) and pictures are less

likely than written words to invite the use of strategies which interfere with automatic encoding (Katz, 1987).

The stimulus for this experiment consisted of a book of pictures. The book contained 50 pictures, plus an 8-picture practice set. Plastic photo pages were lined with black posterpaper and inserted into a spiral ringbinder. When open, 2 pages provided an area of 37 cm by 26 cm and were divided into quadrants by the ringbinder and a horizontal white line. Four pictures were included in the 2-page area, one in each quadrant. The pictures were all black and white and were selected to represent up-to-date and easily recognizable reproductions of common objects. The 50 pictures represented five items from each of 10 conceptual categories. Table 1 lists the pictures used as stimuli.

An 8-picture sample task was contained in the first 2 pages of the book followed by 12 pages of four pictures each and 1 page of two pictures. Two blank pages, with quadrants outlined, were included at the end of the book for the relocation test. The pictures were randomly arranged except that the four pictures in a viewing area each came from a different conceptual category. A set of 50 randomly arranged pictures identical to those in the book was used for the relocation test.

To ensure recognizability of the pictures, that objects and conceptual categories were within the repertoire of typical students meeting the selection criteria, and that the scripted instructions were specific, comprehensive, and

Table 1
Pictures Used as Stimuli

Animals	Body Parts	Food
Cat	Ear	Apple
Cow	Eye	Hamburger
Fish	Foot	Ice Cream
Horse	Hand	Milk
Rabbit	Lips	Pie
Toys	Clothing	Vehicles
Ball	Belt	Airplane
Bat	Dress	Car
Bicycle	Hat	Fire truck
Kite	Shoe	Train
Doll	Suit	Truck
Kitchen Utensils	Furniture	Tools
Cup	Bed	Hammer
Fork	Chair	Ladder
Pan	Desk	Paintbrush
Spoon	Sofa	Saw
Toaster	Table	Shovel
School Supplies		
Book		
Computer		
Pencil		
Ruler		
Scissors		

understandable to the participants, a pilot test of the memory task and recall and relocation phases was conducted. Participants in the pilot study were 5 students without mental retardation aged 10 through 15 and 10 students aged 10 through 15 classified as TMH. Any pictures not easily recognizable were replaced with others that had been readily named by the pilot participants. The scripted instructions were revised as needed based on feedback from the pilot test.

Procedures

To ensure reliability in presentation to each participant, scripted instructions were developed and typed on heavy paper for ease in handling by the experimenter. The experimenter was either the author, an undergraduate or graduate education student, or a person experienced in working with students in special education. Special training was provided to the examiners which consisted of a review of the procedures with the author, observations of sessions conducted by the author, and observations of sessions conducted by each examiner until 100% reliability in administration procedures was obtained. Reliability among experimenters was maintained by the interrater reliability procedures outlined in the Data Treatment section of this chapter.

There were four phases for each participant: memory task, recall test, relocation test, and follow-up. Figure 1 displays the phases.

The follow-up test of secondary memory was administered by the examiner administering the initial memory recall and relocation tasks. Each session was recorded on an audio cassette recorder for use in determining reliability of both encoding instructions and recording of responses. Instructions for examiners are included in Appendix C. The complete scripted instructions for each experimental condition are presented in Appendix D. Data sheets used for recording responses are included in Appendix E. Data sheets

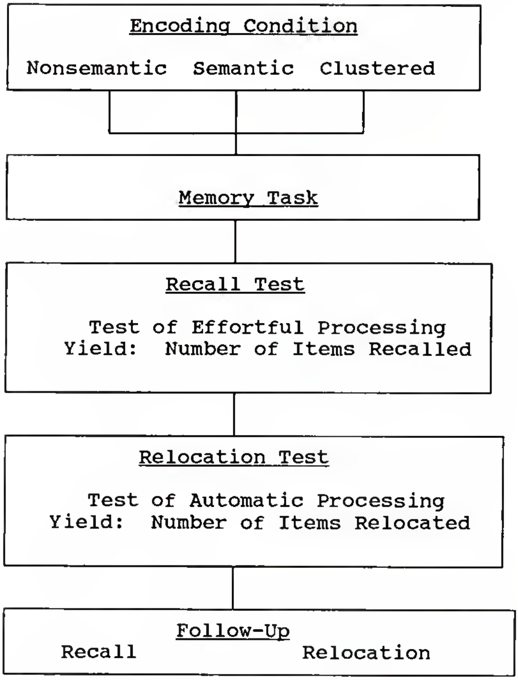

Figure 1. Experimental Procedures Based on Encoding Condition

and scripted instructions were color coded and assembled in packets based on encoding condition for ease in handling and increased reliability.

Memory Task

Activity 1: Encoding instructions. The experimental condition assigned to each participant determined the encoding instructions received by that participant. Participants from Group 1, the nonsemantic-encoding instruction group, were told to "name each picture."

Participants from the semantic-encoding condition, Group 2, were told to name each picture and either tell what the object is used for or tell something interesting about the picture. Participants from Group 3, the clustered encoding group, were asked to name each picture and then name another item from the same conceptual category. All participants from all groups were told that they would be asked to recall as many pictures as possible following completion of the task.

Activity 2: Materials. Participants were asked to look at the pictures at a self-paced rate. They were not allowed to turn back to the pages previously seen.

Activity 3: Practice set. Participants were shown the 8-picture practice set and were asked to recall as many pictures as possible. Participants not able to name any two pictures from the practice set were excluded from the remainder of the task. An additional participant was randomly selected from the available pool of potential participants meeting selection criteria to replace any participant excluded due to inability to name the items in the pictures presented. No mention of location was made in the instructions.

Activity 4: Task. When each subject was comfortable with the procedures of the experiment, the main task was introduced. Participants were told that the task for this part of the experiment was the same as the practice set, just longer. If the participant was unable to name a

picture, the experimenter provided the name. Appropriate substitutions (e.g., substituting shoe for boot) were accepted and noted on the data sheet by the examiner. Inability to name pictured items correctly could indicate difficulty encoding item information or lack of understanding of task requirements. Both possibilities were seen by Ellis et al. (1987) as task-related variables which could interfere with tests of automatic processing. Therefore, participants not able to name two or more pictures were excluded from the test and an additional participant was randomly selected from those meeting the eligibility criteria and for whom parental permission had been received.

Recall Test: Test of Effortful Processing

Activity 1: Recall activity. After viewing and naming the pictures, participants were given 4 minutes for recall. Free recall was requested from participants from Groups 1 and 2. For free-recall procedures, participants were asked to name as many pictures as could be remembered. For participants from Group 3, recall was requested in categories. For example, participants in Group 3 were asked to name as many vehicles as could be remembered.

Activity 2: Recall outcomes. As participants recalled the items pictured, the names were recorded by the examiner. Total study time was recorded as was position recall. Incorrect names consistently used, for example, objects

named incorrectly and recalled with this same name, were accepted.

Relocation Test: Test of Automatic Processing

Activity 1: Relocation activity. Following the 4-minute recall interval, participants were asked to place the pictures in their original locations using the blank pages at the back of the picture book. Identical procedures were used for item relocation for all experimental conditions.

A set of pictures identical to those in the picture book were randomly arranged and used for the relocation test. Participants were shown one picture at a time and asked to name the quadrant where it had first appeared. No feedback was given as to the correctness of the response. Two or more pictures from the same location were not tested consecutively.

Activity 2: Relocation outcomes. The picture location named by the participant was recorded by the examiner to determine the total number of pictures correctly relocated. This task was performed to test the ability to recall location when encoding had not been provided for that task. Differential processing of item recall and item relocation data would provide support for Hasher and Zacks' theory of automatic and effortful processing. Further support for the theory of automaticity would be offered if no differences were noted in automatic processing of location across developmental levels and encoding conditions.

Follow-up: Test of Secondary Memory

Activity 1: Recall follow-up. The recall exercise was repeated approximately 24 hours after the initial testing. During follow-up testing, the participants were not shown the picture book. Only the recall and relocation phases of the test were repeated. Participants were again given a 4-minute recall period with free recall requested from Groups 1 and 2 and clustered recall requested from Group 3.

Activity 2: Relocation follow-up. Participants were presented with a reordered version of the 50 pictures and the relocation test was repeated using the same procedures as used in the original relocation test. As test-wiseness now existed for the relocation test, relocation data could no longer be considered a measure of automatic processing. This phase was repeated, however, to determine if deterioration of automatically processed information occurred differentially based on encoding condition or developmental level.

Turnure (1991) reported an empirical basis for identification of any test over 20 seconds as a test of transfer of information from short-term to long-term (secondary) storage. Turnure questioned the use of this short-delay interval as a simple repetition test, however, and recommended a minimum extended retest criterion interval of 1 hour. For the current test, a 24-hour delay interval was selected to be consistent with previous research using similar recall and relocation exercises (Ellis et al., 1987, Katz, 1987) and to avoid potential floor effects that might

exist with a longer delay interval with the group classified as TMH.

Data Treatment

The recording of 20% of testing sessions was reviewed to verify the accuracy in the presentation of instructions as well as accuracy in the recording of the other measured variables. Additionally, 20% of the data sheets were reviewed to verify correctness of computations. All reliability verifications were completed by persons who (a) were independent of the examiner, (b) had advanced training in special education, and (c) received specific training on data recording procedures from the researcher. Any errors located in either data recording or data computation were corrected.

Interrater reliability of recordings by the experimenter and independent transcriber was calculated by the percentage agreement method of number of agreements plus number of disagreements times 100. Percentage agreements are shown in Table 2.

Table 2
Interrater Reliability

Recording of Data	
Response Item	% Agreement
Instruction presentation	97%
Number items recalled	99%
Number locations recalled	98.85%
Computation of Data	% Agreement
Number items recalled	100%
Number items relocated	100%

For this experiment, dependent variables included number of pictures recalled and number of picture locations recalled. An optimum score of 50 was available for both variables. Independent variables included encoding condition (nonsemantic, semantic, and clustered), developmental level (EMH, TMH, and nonretarded), and retention interval (immediate and long term).

Analyses

Inferential statistics were conducted for each hypothesis. The latest version of Statistical Analysis Systems (SAS) was employed to complete data analysis including Lindquist Type III (split-plot) analysis of variance (ANOVA) and Tukey's procedures. The SAS program is widely use in the field of social sciences for statistical analysis. A .05 level of significance was chosen as the criterion for rejecting or failing to reject the null hypotheses.

The results of each hypothesis were analyzed by a Lindquist Type III ANOVA procedure (developmental level by encoding condition by retention interval) with repeated measures on the last dimension. The Lindquist Type III ANOVA design is appropriate for use when three factors are involved and repeated measures are made across all levels of one factor. The Lindquist design, also known as a 3-factor ANOVA with repeated measures on one factor or a split-plot factorial ANOVA, allows the researcher to answer seven research questions: three concerning main effects, three

with first-order (two-way) interactions, and one with second-order (three-way) interactions (Huck, Cormier, & Bounds, 1974). The main effects were used to test hypotheses one and three. Interaction effects were used to analyze hypotheses two and four.

Tukey's studentized range statistic was used in post hoc analysis to investigate significant effects and to determine whether there were significant differences between the means for each of the three developmental levels. The Tukey procedure may be used in all cases where a significant $\underline{F}$ is obtained in the ANOVA calculation and allows for evaluation of all pair-wise comparisons (Bartz, 1981; Huck et al., 1974). It can be used for groups of unequal size (Bartz, 1981; Box, Hunter, & Hunter, 1978), and all tests have a level of significance which is, at most, equal to alpha. Thus, the possibility of Type I error, rejecting the null hypothesis when it is true, is reduced (Winer, 1971).

Supplemental Analyses

Post hoc analyses were used to investigate the independence of automatically and effortfully processed information. Specifically, analyses were conducted to examine retention and determine the relationship of study time and intrusion errors to recall and relocation performance. Retention was evaluated using a percent change score to determine if deterioration in performance from day one to day two occurred differently for recall and relocation information. Pearson Product Moment Correlations

were calculated to determine if study time, the time used by each participant to encode the 50-item set, was related to either recall or relocation. The third post hoc analysis investigated intrusion errors, or recalling items not in the picture book. Correlation coefficients were calculated to determine if the number of intrusion errors experienced by a participant was related to his or her recall and relocation performance.

Summary

In Chapter 3 the methods and procedures of the current study were outlined. Data were collected through the use of a picture recall and picture relocation task to determine if the ability of students with and without mental retardation to recall prior stimuli supported Hasher and Zacks' theory of automaticity. A follow-up test of secondary memory was conducted 24 hours after the initial recall and relocation tasks. Inferential statistics were employed to describe the variables and examine if differences occurred across developmental levels, encoding conditions, and retention intervals. Results of these procedures are presented in Chapter 4.

Chapter 4
DATA PRESENTATION AND ANALYSIS

The results of the present study are presented in Chapter 4. Results from the Lindquist Type III analysis of variance (ANOVA) with repeated measures are provided and analyzed as related to the hypotheses stated in Chapter 3. This chapter is divided into four sections: Participant Characteristics, Recall and Relocation Performance, Post Hoc Analyses, and Summary of the Results.

Participant Characteristics

Students aged 10 through 15 from 11 schools in a district in west central Florida were included in the study. Of the total 180 participants, 52.2% were female and 47.8% were male; 68.3% were white and 31.7% were minority. Minority status included 1 student classified by the district as Asian-American, 53 students classified as African-American, and 3 students classified as Hispanic. Socioeconomic status (SES) was based on eligibility for free or fee-reduced lunch programs. Of the study participants, 45% did not receive lunch assistance while 55% did receive such assistance. The 180 participants constituted three groups: 60 EMH, 60 TMH, and 60 peers without retardation of similar chronological age. Personal characteristics of the

participants, analyzed by developmental level, are presented in Table 3.

Table 3
Percent of Personal Characteristics by Developmental Level

	Mean IQ[a]	Mean Age	Race White	Race Minority	SES[b] Yes	SES[b] No	Sex Male	Sex Female
Non-retarded	-	12.7	95	5	20.0	80.0	40.0	60.0
EMH	65.7	12.0	35	65	91.6	8.33	48.3	51.7
TMH	44.1	12.6	75	25	59.3	46.7	55.0	45.0

[a] IQ scores not available for students without retardation
[b] SES = socioeconomic status. Yes = eligible for free or fee-reduced lunch. No = not eligible for free or fee-reduced lunch.

Participants were randomly assigned to one of three experimental conditions: Group 1, nonsemantic encoding; Group 2, semantic encoding; and Group 3, clustered encoding. The characteristic of the participants by encoding condition groups are presented in Table 4.

Table 4
Percent of Personal Characteristics by Encoding Condition

	Mean Age	Race White	Race Minority	SES[a] Yes	SES[a] No	Sex Male	Sex Female
Nonsemantic	12.3	70.1	29.3	58.6	41.4	58.6	41.4
Semantic	12.4	70.0	30.0	53.3	46.7	43.3	56.7
Clustered	12.6	64.5	34.5	53.2	46.7	42.0	58.1

[a] SES = socioeconomic status. Yes = eligible for free or fee-reduced lunch. No = not eligible for free or fee-reduced lunch.

Personal characteristic data further examined by encoding subgroups within each developmental level are shown in Table 5.

Table 5
Percent of Personal Characteristics by Encoding Condition within Developmental Level

	Mean IQ[a]	Mean Age	Race White	Race Minority	SES[b] Yes	SES[b] No	Sex Male	Sex Female
Non-retarded								
Gr. 1	-	12.5	90.0	10.0	25.0	75.0	45.0	55.0
Gr. 2	-	12.6	95.0	5.0	25.0	75.0	40.0	60.0
Gr. 3	-	12.8	100	0	10.0	90.0	35.0	65.0
EMH								
Gr. 1	66.3	12.1	38.9	61.1	88.9	11.1	66.7	33.3
Gr. 2	64.9	12.0	35.0	65.0	90.0	10.0	40.0	60.0
Gr. 3	65.9	12.0	31.8	68.2	95.4	4.6	41.0	59.1
TMH								
Gr. 1	45.0	12.4	80.0	20.0	65.0	35.0	65.0	35.0
Gr. 2	44.4	12.7	80.0	20.0	45.0	55.0	50.0	50.0
Gr. 3	42.9	12.9	65.0	35.0	50.0	50.0	50.0	50.0

[a] IQ scores not available for students without retardation
[b] SES = socioeconomic status. Yes = eligible for free or fee-reduced lunch. No = not eligible for free or fee-reduced lunch.

In order to determine if significant differences in the distribution of personal characteristics existed, chi-square analyses were computed. A significant association was noted between age and encoding condition ($X^2 = 12.423$ (df=6) $p = .053$) and between age and developmental level ($X^2 = 20.189$ (df=6) $p = .003$). For example, 20% (n=12) of the participants in encoding Group 2 were 13 years of age while 29% (n=17) of

Group 1 participants were of this age. Furthermore, 40% (n=24) of the students without mental retardation were 13 years old while only 15% (n=9) of the students classified as EMH were 13 years old. Additional significant association were noted between race and developmental level (X^2 = 51.759 (df=2) p = .000) and SES and developmental level (X^2 = 62.357 (df=2) p = .000). However, when encoding condition was controlled for within each developmental level, significant association for age, race, and SES no longer existed. Results of chi-square distributions for age, race, sex, and SES are shown in Table 6.

Table 6
Chi-Square Analysis of Encoding Condition by Personal Characteristics within Developmental Level

	Chi-square	df	P value
Age			
Non-retarded	6.467	6	p = .373
EMH	7.621	6	p = .267
TMH	5.971	6	p = .426
Race			
Non-retarded	2.105	2	p = .349
EMH	.218	2	p = .897
TMH	1.600	2	p = .449
Sex			
Non-retarded	.417	2	p = .812
EMH	3.464	2	p = .177
TMH	1.212	2	p = .545
SES			
Non-retarded	1.875	2	p = .392
EMH	.668	2	p = .716
TMH	1.741	2	p = .419

As all p values were greater than .05, there was no evidence to support the conclusion that there was a significant association between personal characteristics and the encoding condition within each developmental level. Therefore, randomization to encoding condition successfully distributed individual characteristics so that within each developmental level individual characteristics were not associated with encoding condition.

Recall and Relocation Performance

The number of pictures recalled and number of picture locations recalled were the dependent measures in the present study. An optimum score of 50 was available for both variables. Independent measures included developmental level (TMH, EMH, and nonretarded); encoding condition (nonsemantic, semantic, and clustered); and retention interval (immediate and long-term). Summary statistics of recall and relocation performance by developmental level and encoding condition are presented in Table 7.

The following sections contain an analysis of the effect of developmental level and encoding condition on immediate and 24-hour delay recall performance (hypothesis one) followed by an analysis of immediate and 24-hour delay relocation performance (hypothesis three). The interaction of recall and relocation with the independent variables are then discussed (hypotheses two and four).

Table 7
Means and Standard Deviations of Recall and Relocation Performance by Developmental Level and Encoding Condition

	Recall 1	Recall 2	Relocation 1	Relocation 2
Non-retarded				
Gr. 1	17.8	19.9	36.5	28.0
	(5.9)	(7.0)	(7.0)	(6.7)
Gr. 2	20.6	22.0	39.6	29.9
	(4.9)	(4.5)	(5.0)	(6.7)
Gr. 3	28.9	31.0	39.2	30.9
	(3.9)	(5.0)	(5.7)	(6.4)
EMH				
Gr. 1	11.4	11.1	29.7	23.6
	(3.9)	(4.0)	(10.3)	(8.5)
Gr. 2	13.2	13.4	33.5	21.1
	(3.2)	(4.0)	(9.8)	(8.8)
Gr. 3	22.6	21.8	28.6	22.0
	(6.7)	(5.7)	(10.5)	(7.9)
TMH				
Gr. 1	8.6	8.6	20.5	15.1
	(3.8)	(5.6)	(9.1)	(4.1)
Gr. 2	12.5	7.4	19.3	16.5
	(7.4)	(4.6)	(9.0)	(6.3)
Gr. 3	16.1	18.3	20.7	16.4
	(7.7)	(7.6)	(11.9)	(6.6)

Recall Performance

It was hypothesized that there would be no statistically significant difference in the mean number of items recalled following presentation of 50 pictures as a function of (a) three developmental levels of TMH, EMH, and peers without retardation of similar chronological ages; (b) three encoding conditions of nonsemantic, semantic, and clustered; or (c) two retention intervals of immediate and 24-hour recall. A

significant main effect for either developmental level or encoding condition for either day one or day two recall performance would result in rejection of the null hypothesis. The recall performance on both day one and day two for all students is shown in Table 8 for both developmental level and encoding condition.

Table 8
Mean Number of Items Recalled by Developmental Level and Encoding Condition

	Recall Day One	Recall Day Two
Developmental Level		
Nonretarded	22.4	24.3
EMH	16.1	15.8
TMH	12.4	11.4
Encoding Condition		
Nonsemantic	12.6	13.3
Semantic	15.4	14.2
Clustered	22.3	23.7

Immediate recall. Recall performance on day one was analyzed with ANOVA designs to determine the effect of developmental level and encoding condition on immediate recall. A significant main effect at the .05 level ([F (2,177)=31.47, p<.001]) was found for developmental level. These results are shown in the Table 9.

Table 9
Source Table for Effect of Developmental Level on Recall Performance, Day One

Source	df	F	p
Developmental Level	2	31.47	.0001 *
Error	177		

*$p < .05$

A second ANOVA was completed to determine the effect of encoding condition on recall performance. The significant main effect which resulted from this analysis is shown in Table 10 ([F (2,177)=32.87, p<.0001]).

Table 10
Source Table for Effect of Encoding Condition on Recall Performance, Day One

Source	df	F	p
Encoding Condition	2	32.87	.0001 *
Error	177		

*$p < .05$

Follow-up analyses using Tukey's procedure was performed to investigate the source of these differences in immediate recall performance. Significant differences by all three developmental levels and all encoding conditions were noted. On day one, the students without mental retardation recalled more than those classified as EMH who recalled more than students classified as TMH. The clustered encoding group as a

whole recalled more than those participants in the semantic group who recalled more than those from the nonsemantic group. Significant differences were noted in the mean number of items recalled by the clustered encoding group and the semantic group and between the clustered and nonsemantic groups but not between the semantic and nonsemantic groups.

Long term recall. Additional ANOVAs were completed to investigate the effect of developmental level and encoding condition on 24-hour delay recall. Again, a significant main effect for developmental level was noted at the .05 level ([F (2,177) = 48.72, p<.0001]). Results are shown in Table 11.

Table 11
Source Table for Effect of Developmental Level on Recall Performance, Day Two

Source	df	F	p
Developmental Level	2	48.72	.0001 *
Error	177		

*p< .05

Tukey's follow-up procedures revealed significant differences in long term recall for all three developmental levels as again the students without mental retardation recalled more than EMH who recalled more than TMH.

A significant main effect was noted at the .05 level for encoding condition ([F (2.177) = 34.10, p<.0001]). Results of the ANOVA are shown in Table 12.

Table 12
Source Table for Effect of Encoding Condition on Recall Performance, Day Two

Source	df	F	p
Encoding Condition	2	34.10	.0001 *
Error	177		

*$p < .05$

As on day one, significant differences were noted in recall on day two between nonsemantic and clustered encoding conditions and semantic and clustered but not between semantic and nonsemantic conditions. In conclusion, both developmental level and encoding condition made a significant difference in recall performance on both day one and day two. Therefore, the first hypothesis was rejected.

Relocation Performance

The third hypothesis was that there would be no statistically significant differences in the mean number of items relocated following presentation of 50 pictures as a function of (a) three developmental levels of TMH, EMH, and peers without retardation of similar chronological ages; (b) three encoding condition of nonsemantic, semantic, and clustered; or (c) two retention intervals of immediate and 24-hour recall. A significant main effect for either developmental level or encoding condition for either day one or day two relocation performance would result in rejection of the null hypothesis. The relocation performance on both day one

one and day two for all students is shown in Table 13 for both developmental level and encoding condition.

Table 13
Mean Number of Items Relocated by Developmental Level and Encoding Condition

	Relocation Day One	Relocation Day Two
Developmental Level		
Nonretarded	38.4	29.5
EMH	30.6	22.2
TMH	20.1	16.0
Encoding Condition		
Nonsemantic	28.8	22.1
Semantic	30.8	22.5
Clustered	29.5	23.0

Immediate relocation. Investigation of the effect of developmental level on immediate relocation was performed using an ANOVA design. This investigation revealed a significant main effect ([F (2,177) = 63.36, $p<.0001$]) for developmental level. Results of this investigation are presented in Table 14.

Table 14
Source Table for Effect of Developmental Level on Relocation Performance, Day One

Source	df	F	p
Developmental Level	2	63.36	.0001 *
Error	177		

*$p<.05$

Tukey's statistic computed to determine the source of these differences provided evidence for significant differences among all developmental levels. The students without retardation relocated more pictures correctly than those participants classified as EMH who relocated more pictures correctly than TMH.

Further investigation of relocation performance using an ANOVA design failed to reveal a significant main effect for encoding condition ([F (2,177) = .43, p<.6480]). Results of this investigation are shown in Table 15.

Table 15
Source Table for Effect of Encoding Condition on Relocation Performance, Day One

Source	df	F	p
Encoding Condition	2	.43	.6580
Error	177		

Long term relocation. For 24-hour delay relocation performance, a significant difference in the number of items relocated was noted between developmental levels ([F (2,177) = 57.40, p<.0001]). The results are summarized in Table 16.

Using the Tukey's procedure, the investigator again found significant differences in relocation performance for all developmental levels. Students without mental retardation relocated more than EMH who relocated more than students classified as TMH.

Table 16
Source Table for Effect of Developmental Level on Relocation Performance, Day Two

Source	df	F	p
Developmental Level	2	57.40	.0001 *
Error	177		

*p< .05

An additional ANOVA completed to investigate the effect of encoding condition on relocation performance on day two revealed no significant differences ([F (2,177) = .17, p<.8480.]). The results are included in Table 17.

Table 17
Source Table for Effect of Encoding Condition on Relocation Performance, Day Two

Source	df	F	p
Encoding Condition	2	.17	.8480
Error	177		

In summary, a significant difference was not shown in the number of pictures relocated either on day one or day two due to encoding condition. However, as developmental level had a significant effect on the relocation performance of participants on both day one and day two, hypothesis three was rejected.

Recall and Relocation Interaction

Following the main effect analyses, the researcher questioned the interaction of recall and relocation performance with developmental level and encoding condition between immediate and 24-hour delayed performance. Two null hypotheses were stated. First, it was hypothesized that there would be no statistically significant effect on the mean number of items recalled following presentation of 50 pictures as a function of the two-way or three-way interaction of the (a) three developmental levels of TMH, EMH, and peers without retardation of similar chronological ages; (b) three encoding conditions of nonsemantic, semantic, and clustered; and (c) two retention intervals of immediate and 24-hour recall (hypothesis 2). Additionally, it was hypothesized that there would be no statistically significant effect on the mean number of items relocated following presentation of 50 pictures as a function of the two-way or three-way interaction of the (a) three developmental levels of TMH, EMH, and peers without retardation of similar chronological ages; (b) three encoding conditions of nonsemantic, semantic, and clustered; and (c) two retention intervals of immediate and 24-hour recall (hypothesis four).

Recall. The results for the Lindquist Type III split-plot ANOVA with repeated measures design used to investigate the presence of significant interaction effects for recall are shown in Table 18. As seen in this table, the interaction of developmental level and encoding condition between immediate and 24-hour retention is not significant (F (4,171) = .39

p<.8141]). This lack of significance means that the relationship between each encoding condition within each developmental level is not significantly different. An illustration of this finding can be seen from the data provided in Table 7. The mean number of items recalled for the students classified as TMH were 8.6 for the nonsemantic encoding group, 12.5 for the semantic group and 16.1 for the clustered encoding group. For the students classified as EMH, these totals were 11.4, 13.2, and 22.6, respectively. While, as previously discussed, all EMH encoding groups recalled more than their TMH counterparts, the relationships among the groups did not differ significantly.

Table 18
Source Table of Repeated Measures ANOVA for Recall

Source	df	F	p
Level	2	78.27	.0001 *
Condition	2	68.82	.0001 *
Level * Condition	4	.39	.8141
Error	171		
Retention	1	.43	.5138
Retention * Level	2	7.72	.0006 *
Retention * Condition	2	5.28	.0060 *
Retention * Condition * Level	4	6.07	.0001 *
Error	171		

*p< .05

Significant interaction effects for retention interval, developmental level, and encoding condition ([F (4,171) = 6.07, p<.0001]); retention interval and encoding condition ([F

(2,171) = 5.28, $p<.0060$]); and retention interval and developmental level ([F (2,171) = 7.72, $p<.0006$]) are illustrated also by the results presented in Table 18. Thus, further analysis was needed to investigate recall differences from day one to day two for encoding condition within the three developmental levels.

Further investigation of the developmental level and encoding interaction for immediate and 24-hour retention interval revealed significant differences within the group of students classified as TMH. No significant difference was shown between immediate recall and 24-hour delayed recall for TMH students in the nonsemantic group ([F (1,19) = .00 $p<1.00$]). As shown in Table 7, this group recalled an average of 8.6 items on both days of the procedure. A significant difference was shown by the TMH students in the semantic encoding group between immediate recall and 24-hour delayed recall ([F (1,19) = 16.81, $p<.0006$]). To determine if a relationship existed between relocation performance on day one and day two for this group, the researcher completed further analyses using Pearson Product Moment correlations. These analyses revealed that for TMH students in the semantic encoding group recall from day one to day two was highly and significantly correlated ($r = .67$, $p<.0012$). Recall from day one to day two approached significance for those TMH students assigned to the clustered encoding group ([F (1,19) = 3.80, $p<.066$]). Recall from day one to day two for this group was significantly correlated also ($r=.7714$, $P<.0001$).

From these analyses, a significant interaction was shown among retention interval, developmental level, and encoding condition. Therefore, hypothesis two was rejected.

Relocation. A second Lindquist Type III split-plot ANOVA with repeated measures was completed to determine if interaction effects existed in the number of items correctly relocated between immediate and 24-hour retention (hypothesis four). Results are exhibited in Table 19.

Table 19
Source Table of Repeated Measures ANOVA for Relocation

Source	df	F	p
Level	2	69.87	.0001 *
Condition	2	.36	.6995
Level * Condition	4	.49	.7444
Error	171		
Retention	1	228.82	.0001 *
Retention * Level	2	10.03	.0001 *
Retention * Condition	2	1.55	.2145
Retention * Condition * Level	4	2.75	.0298 *
Error	171		

*$p < .05$

It can be noted from Table 19 that there was no significant interaction between developmental level and encoding condition for the number of items correctly relocated from immediate to 24-hour relocation for all subjects ([F (4,171) = .49, $p<.7444$]). When performance from both day one and day two were considered, however, the interaction of developmental level, encoding condition, and retention

interval was significant ([F (4,171) = 2.75, $p<.0298$]). As the interaction of retention interval and developmental level was significant ([F (2,171) = 10.03, $p<.0001$]), further investigation was undertaken. Fewer items were relocated correctly from day one to day two by all participants. These interval differences were significant by encoding condition for students classified as EMH.

The researcher further analyzed the significant difference in relocation performance from day one to day two for students classified as EMH. The mean number of items relocated for both days of the procedure were examined. Pearson Product Moment correlations were completed, and follow-up procedures from the repeated measures ANOVA were reviewed. The mean number of items relocated can be found in Table 7. For those EMH students in the nonsemantic encoding condition, 29.7 items were relocated correctly on day one compared to 23.6 on day two. This difference of 6.1 items was significant at the .05 level ([F (1,17) = 39.78, $p<.0001$]). A correlation coefficient of .92 ($p<.0001$) supports the contention that, for these students, relocation performance on day one was highly related to their performance on day two. Participants in the semantic encoding condition relocated 12.4 additional items on day one than they did on day two (see Table 7). This difference was also significant ([F (1,19) = 74.64, $p<.0001$]). The increased difference in the number of items correctly located from day one to day two resulted in a decreased but still significant correlation of these two

performance measures ($r = .767$, $p<.0001$) when a Pearson Product Moment correlation was computed. Those EMH participants in the clustered condition relocated 28.6 items correctly on day one compared to 22.0 items on day two for a significant difference of 6.6 items ([$F(1,21) = 18.87$, $p<.0003$]), and a significant correlation coefficient of $r = .737$, $p<.0001$.

In conclusion, an interaction of developmental level, encoding condition, and retention interval was found to have a significant effect on the number of items relocated. Hypothesis four was rejected.

Post Hoc Analysis

To further investigate if item location information was processed independently of item information, three post hoc analysis were completed. These analysis, while not essential in the decision to accept or reject the hypotheses stated in Chapter 3, provide evidence for determining if independence was demonstrated in automatic and effortful processing by the participants in this study.

Item Retention

Retention was evaluated to determine if deterioration of items recalled and relocated occurred differentially over the 24-hour period. A percent change score was calculated as immediate test score minus 24-hour delay test score divided by immediate test score times 100 (Katz, 1987). Percent change data by developmental level and encoding condition are presented in Table 20.

As exhibited in Table 20, gains in the percent change scores for recall were experienced by some students while others experienced deterioration. Participants in all groups experienced a deterioration in relocation performance from day one to day two although the percent of change varied considerably.

Table 20
Percent Change by Developmental Level and Encoding Condition

	Recall Day One to Day Two	Relocation Day One to Day Two
Developmental Level		
Nonretarded	-10.90%	23.32%
EMH	- .74%	24.26%
TMH	5.42%	8.14%
Encoding Condition		
Non-semantic	- 4.76%	20.50%
Semantic	8.32%	19.36%
Clustered	- 9.60%	16.00%

Study Time

Study time represented the amount of time used by each participant to encode the 50 pictures of the entire item set. Table 21 shows an analysis of study time by developmental level and encoding condition.

Participants classified as TMH required longer study times than either EMH students or those participants without retardation. For all three developmental levels, participants in the clustered encoding condition required more study time than participants from the other two encoding groups.

Table 21
Means and Standard Deviations of Study Time by Developmental Level and Encoding Condition

	Mean	Standard Deviation
Nonretarded	4.87	1.80
Nonsemantic	3.20	1.12
Semantic	5.21	.77
Clustered	6.25	1.70
EMH	5.23	2.71
Nonsemantic	2.68	.58
Semantic	4.67	1.36
Clustered	7.91	2.30
TMH	6.93	3.94
Nonsemantic	5.77	4.43
Semantic	7.24	3.23
Clustered	7.95	3.95

Pearson Product correlations were computed to determine the relationship of study time to recall and relocation performance. Correlation coefficients for encoding condition and developmental level are depicted in Table 22.

As illustrated by Table 22, generally relationships of study time to recall were significant. Study time was only significantly, and inversely, related to relocation for participants from the nonsemantic encoding group. When analyzed by developmental level, significant relationships of study time to recall were noted by students classified as EMH ($r = .519$, $p < .001$) and students without mental retardation ($r = .558$, $p < .0001$) and was approaching significance for TMH ($r = -.26$, $p < .06$).

Table 22
Correlation Coefficients of Study Time to Recall and Relocation Performance by Encoding Condition and Developmental Level

		Study Time To Recall Day One	Study Time To Relocation Day One
Nonsemantic	r	-.269	-.363
	p	.0473 *	.0065 *
Semantic	r	-.417	-.186
	p	.0019 *	.1821
Clustered	r	-.304	.123
	p	.024	.37
Nonretarded	r	.558	.312
	p	.0001 *	.020
EMH	r	.519	.058
	p	.0001 *	.672
TMH	r	-.260	.086
	p	.061	.542

*$p < .05$

Intrusion Errors

Due to a disparity in the number of intrusions errors (recalling items not included in the picture book), intrusions were analyzed. The number of intrusion errors on day one ranged from 0 to 29 with a mean of 3.59 and standard deviation of 5.01. Pearson Product Moment correlations were computed to determine if significant relationships existed for intrusion errors and encoding condition subgroups. The results are shown in Table 23.

Table 23
Correlation Coefficients of Intrusion Errors to Recall and Relocation Performance by Encoding Condition and Developmental Level

		Intrusion Errors to Recall Day One	Intrusion Errors to Relocation Day One
Encoding Condition			
Nonsemantic	r	-.240	-.437
	p	.070	.0006 *
Semantic	r	-.182	-.363
	p	.163	.004 *
Clustered	r	-.125	-.250
	p	.333	.049 *
Developmental Level			
Nonretarded	r	.200	-.01
	p	.125	.941
EMH	r	.323	-.194
	p	.012 *	.134
TMH	r	.415	.019
	p	.001 *	.888

*p< .05

For participants classified as TMH and EMH, intrusions were significantly related to recall. Significant inverse relationships resulted between intrusion errors and relocation performance for all encoding conditions.

Summary of Results

Students without mental retardation recalled and relocated more pictures correctly than did students classified as EMH who in turn performed better than students classified as TMH. Additionally, participants from the clustered encoding condition recalled and relocated more than those from the semantic encoding group who surpassed the nonsemantic group.

The hypotheses stated that there would be no statistical effect on recall and relocation among developmental levels, encoding conditions, and retention intervals. The data analyses revealed a statistically significant ($p < .05$) interaction effects. Therefore, all null hypotheses were rejected. Interpretation and discussion of these findings are presented in Chapter 5.

CHAPTER 5
DISCUSSION AND IMPLICATIONS

In this chapter the implications of the present study are considered. Section one includes review of the purpose and objectives of the study with a summary of study methods and a discussion of results of the investigation. The second section contains an interpretation and discussion of results in terms of related literature. Section three contains a summary of the problems and limitations of the study. Implications for teaching students with mental retardation and suggestions for further research are reviewed in section four.

Purpose and Objectives

In this study, effortful and automatic information memory processing by students with and without mental retardation was examined. The first objective was to determine if differences in effortful and automatic processing existed as hypothesized by Hasher and Zacks' theory of automaticity (1979, 1984). The second objective was to determine if the memory processing of persons with and without mental retardation differed by developmental level dependent upon (a) whether the information was automatically or effortfully processed or (b) whether clustering or semantic strategies were applied.

Knowledge of how memory processes function will contribute toward an increased understanding of the application of memory theories. Such knowledge also will provide relevant information to teachers and educational leaders. The information gained from this study may enhance the design of instructional programs to increase educational effectiveness, particularly in the design of programs for teaching functional skills.

Study Methods

In this study, a picture recall and relocation test was completed to determine if differences existed in automatic and effortful processing based on developmental level or encoding condition. Students from three developmental levels participated in the study: students classified as trainable mentally handicapped, educable mentally handicapped, and students without mental retardation. Within each developmental level students were randomly assigned to one of three encoding conditions: non-semantic, semantic, or clustered. A follow-up test of both recall and relocation was conducted approximately 24 hours following the initial examination.

Results of the Investigation

Four hypotheses were stated to investigate recall performance, relocation performance, and the interaction of recall and relocation between retention intervals. In this section the results of the investigation of each hypothesis

are reviewed and other factors related to recall and relocation performance are analyzed.

<u>Hypothesis one</u>. It was hypothesized that there would be no significant differences in recall performance as a function of developmental level, encoding condition, or retention interval. As significant differences were noted on both day one and day two in the mean number of items recalled by all developmental levels and by all encoding conditions, this hypothesis was rejected.

Recall of item information was examined as a test of effortful processing. As students without mental retardation recalled more than students with retardation, evidence is provided for asserting that effortful processing deficits exist for persons with mental retardation. These deficits also were present dependent upon how the information was encoded.

Differences in performance among encoding condition groups verifies that persons with mental retardation can be induced to use elaborative or clustering techniques and that these mediators can improve recall performance. Problems have been noted, however, in the long-term retention of control strategies by persons with mental retardation and the generalization of the use of these strategies to new tasks (Brown, 1974). How encoding condition influenced the performance of students from the various developmental levels will be discussed as interaction effects in the section reviewing hypothesis two.

The fact that students without mental retardation recalled more than students with mental retardation is not surprising and supports the theory of automaticity. In developing the theory of automaticity, Hasher and Zacks (1979, 1984) asserted that memory is influenced by how information is acquired and encoded. Effortfully processed information, such as the recall of item information, requires the intentional application of strategic processes, sufficient memory storage capacity, and effective and efficient retrieval mechanisms. All of these areas have been shown to vary by developmental level and be deficient in persons with mental retardation (Belmont & Mitchell, 1987; Brown, 1974; Hasher & Zacks, 1979, 1984; Merrill, 1990).

Hypothesis two. It was stated in the second hypothesis that there would be no significant differences in recall performance as a function of the two-way or three-way interaction between developmental level, encoding condition, and retention interval. A failure to find a significant interaction effect between developmental level and encoding condition when the performance from both day one and day two were considered together establishes the fact that relationships among encoding conditions within each developmental level did not differ significantly. For example, the relationship of the recall performance of students classified as EMH from the semantic group and from the nonsemantic group did not differ significantly from the

relationship between TMH students who were similarly assigned.

Turnure (1991) described the lower performance of persons with mental retardation on memory tests as indicative of qualitative memory deficiencies. Turnure continued, however, that when persons with mental retardation show patterns of performance similar to other populations, such as the patterns just described, only quantitative deviations from normal performance are implied. While Brown (1974) maintained that the ability to construct and execute a plan or to benefit from the use of control strategies may be dependent on maturity level, Turnure's belief emphasized that persons with mental retardation do have both implicit (unintentional) and explicit (intentional) memory systems, although one or both systems may operate quantitatively different from typical performance.

When performance was assessed from day one to day two, a significant three-way interaction resulted. Recall performance was significantly different from day one to day two dependent on developmental level and encoding condition. Students without retardation from all encoding conditions showed an increase in the number of items recalled from day one to day two. This ability to recall more items after 24-hours than at immediate recall did not hold true for all encoding groups from the other developmental levels.

The use of clustering and semantic strategies is of particular interest when comparing performance from day one to day two for participants with retardation. The students in the clustered encoding condition who were classified as EMH had a slight decrease in recall performance from day one to day two while their TMH counterparts showed an increase in the number of items recalled. The opposite was true for students in the semantic group. Therefore, the encoding condition assigned had varying degrees of effectiveness on recall performance depending on the developmental level of the student.

The significant difference in performance from day one to day two relative to a student's developmental level and assignment to encoding condition resulted in this hypothesis being rejected. The influence of developmental level, encoding condition, and retention interval on recall performance was anticipated based on the theory of automaticity. When tasks require the application of effort or intention, individual differences and instruction can prejudice the outcome.

Hypothesis three. It was stated in hypothesis three that there would be no significant differences in relocation performance as a function of developmental level, encoding condition, or retention interval. Significant differences on both day one and day two were noted in the mean number of items relocated by all developmental levels but not by encoding conditions. The condition to which a student was

assigned did not affect relocation ability. Participants from the nonsemantic, semantic, and clustered groups relocated a mean of 28.8, 30.8, and 29.5 items, respectively (see Table 13).

The failure to find a significant difference in the number of items correctly relocated among the three encoding conditions when students from all three developmental levels were considered supports the theory of automaticity. According to Hasher and Zacks (1979, 1984), automatic processes are not sensitive to encoding conditions. Nonetheless, the influence of developmental level on relocation performance is counter to the theoretical assumption concerning automatic processing and caused this hypothesis to be rejected.

A review of the data on the influence of developmental level on relocation performance reveals that students without mental retardation relocated more pictures correctly than did any of their counterparts with mental retardation. This finding was unexpected in light of Hasher and Zacks' contention that automatically processed information is insensitive to developmental differences. In their discussion of memory for frequency of occurrence, Hasher and Zacks (1984) did acknowledge that the use of memory skills and knowledge about the function of memory in general and a person's own memory in particular both show developmental trends at least through age 4 or 5. While they did not discuss persons with mental retardation per se, this

interpretation may be applicable to explain the findings of the present study. Brown (1974) agreed that the decreased ability of persons with mental retardation to automatically encode spatial location information may be due to immature development of memory skills in general or differences in the development of memory capacity. The fact that students classified as EMH relocated more than their TMH peers but less than students without retardation contributes to the explanation that, at least for some people, ability to benefit from incidental learning is developmentally influenced.

It is important to note that a disparity in relocation performance was noted by students classified as TMH. The number of items correctly relocated on day one for this group ranged from 7 through 46. Of the 60 students in this group, 8 located more than 30 of the 50 items correctly. Six participants relocated less than 10 correctly. The variance in the ability to correctly relocate pictures leads to the conclusion that at least some of the students classified as TMH were sensitive to this information. It is important to note that the TMH participants were those most likely to be influenced by organic etiology (Burack & Zigler, 1990) or to experience problems in retrieval (Turnure, 1991).

It is possible also that participants classified as TMH found the tasks overwhelming and abandoned efforts based on expectancy for failure (Beirne-Smith, Patton, & Ittenbach, 1994). Belmont and Mitchell (1987) stated that performance

on automatic processing tasks is influenced by prior experiences and expectations of task difficulty. Processes become automatic with practice or when working with familiar materials and within known ability levels (Belmont & Mitchell, 1987). While in this study the researcher did not test either the effect of practice or perceptions of task difficulty with students with retardation, anecdotal evidence was provided by examiners who reported apparent enhanced attention and performance when (a) demands were decreased when students were asked to "name one additional picture" instead of being asked "what else did you see" or "tell me other pictures you saw", (b) nonspecific praise was given, and (c) interruptions and distractions were used to break perseveration patterns in relocation recall.

Hypothesis four. In the fourth hypothesis it was stated that there would be no significant differences in relocation performance as a function of the two-way or three-way interaction between developmental level, encoding condition, and retention interval. A significant three-way interaction resulted in this hypothesis being rejected.

This significant interaction provided evidence that the encoding condition within each developmental level made a difference in relocation performance from day one to day two. Relocation performance decreased day one to day two for all encoding subgroups. However, the relationship of day one to day two relocation performance for EMH students in the semantic encoding group was significantly different

from the performance of EMH students in the other two groups.

Differences in relocation performance from day one to day two do not support Hasher and Zack's (1979, 1984) contention that automatically encoded information, such as memory for spatial location, is insensitive to intervening variables. The findings of this study exposed differences in relocation performance due to developmental level and encoding condition. From the interaction effects present when retention interval was included in the analysis, it can be concluded that memory for relocation is subject to differential rates of forgetting as well.

Related analyses. Three further analyses were conducted by the researcher to determine if independence was demonstrated in automatic and effortful processing by the participants in this study. Katz (1987) indicated that to accurately assess automatic processing the component being tested should be distinguishable from the whole-task performance. Retention, study time, and intrusion errors were examined. From the results conclusions can be drawn as to the extent to which automatic and effortful processing components functioned independently in the present study.

Retention of either recall or relocation information from day one to day two may have been the result of several factors. Increases in recall performance were noted by some students, particularly students without retardation and

students in the nonsemantic and clustered encoding conditions. As some groups experienced an increase in recall performance from day one to day two but all participants experienced a reduction in the number of correct relocations retained, it can be concluded that item recall and item relocation are subject to differential rates of forgetting. Therefore, recall and retention are either processed independently, as theorized by Hasher and Zacks (1979, 1984), or retention is affected by variables other than item encoding. The fact that more location information than recall information was lost by all groups suggests that item relocation, or automatically processed information, is more sensitive to forgetting.

Study time represented the amount of time used by each participant to encode the 50 pictures of the entire item set. Participants classified as TMH and those in the clustered encoding condition required longer study time, but this increased time did not insure improved performance. In fact, for participants from the nonsemantic and semantic groups, significant, inverse relationships indicated that as study time increased, recall performance decreased. Study time was not significantly related to relocation performance except for nonsemantic participants. Therefore, as study time was differentially related to item recall and relocation, support is provided for the independent processing of these two attributes.

Intrusion errors represent an interruption of to-be-remembered information with new information supplied by the participant. For students classified as EMH and TMH intrusion errors were positively related to recall. Such a result may have been due to what was described by some examiners as a "shotgun" effect experienced when, during the recall phase, the student named a variety of items in rapid succession. As some items named were those shown in the picture set, recall scores increased, but an increased number of intrusion errors resulted as well.

Inverse, significant relationships were shown between intrusion errors and item relocation for all encoding conditions. It can be suggested, therefore, that the processing of extraneous item information interfered with automatic processing. As the number of intrusion errors was related to both recall and relocation, support is not provided for the total independence of these two constructs.

Summary. The results of this study confirm that students with retardation did less well than their peers without retardation on both tests of automatic and effortful processing. When a student is required to retain information over a period such as the retention interval examined in this study, both the developmental level of the student and the instructions given when the information is presented for memory will have an impact on the amount of information retained. Evidence from related analyses bring

into question the total independence of automatic and effortful processing.

Interpretation and Discussion of Related Findings

In this section, the results of the present research are interpreted in terms of related studies. The effects of developmental level and encoding condition on information processing are addressed specifically. Possible explanations for the present findings are given based on previous research efforts.

Developmental Level

In the present study, the developmental level of the participant was associated with both recall and relocation performance. Prior researchers into memory performance of persons with mental retardation have made comparable findings for effortfully processed information. Recall performance and ability has been found to be related to both age and IQ (Calfee, 1969; Dugas & Kellas, 1974; Ellis et al., 1985; Ellis et al., 1989a; Lamberts, 1979). Additionally, persons with mental retardation have been found to not retrieve as many items from storage as persons without mental retardation (Glidden & Mar, 1977). Varnhagen et al. (1987) explained that persons with mental retardation have less efficient effortful memory processing systems, faster stimulus decay, and greater stimulus interference.

Findings of prior researchers into automatic processing by persons with mental retardation have not been as straightforward. Incidental memory has been found to not be

deficient when compared to that of peers without retardation and to be unrelated to age, intelligence, or type of instruction by some researchers (Burack & Zigler, 1990; Ellis et al., 1989a; Schultz, 1983). Katz (1987) reported that age related deficits for automatically processed information have been found. Merrill (1990) reported differences in information processing between persons with and without mental retardation exist primarily when effortful, but not automatic, memory is required. Stratford (1979), on the other hand, found short-term memory deficits for the automatically processed attributes of size, form, and order. Possible explanations for the discrepancies found in the study of automatic processing include (a) prior instructions received by the student, (b) the type of information and procedures used to study automatic processing, and (c) the size of the memory load. One possible explanation for the present finding that automatic processing differed by developmental level may be based on comparisons being made among developmental levels of students of similar chronological ages. Chronological age comparisons generally had not been the subject of prior researchers.

Encoding Condition

Encoding refers to the establishment of an internal representation of a stimuli for storage and retrieval. Persons with mental retardation have been reported to be encoding deficient while persons who claim to use memory

strategies are found to have higher and more accurate recall (Ellis et al., 1985). Encoding condition was found to be a significant variable in both recall and relocation performance in the present study.

In agreement with the findings of the present study, the use of semantic or clustering strategies has been found to influence recall (Becker & Morrison, 1978; Bilsky, 1976; Gerjouy & Alvarez, 1969). Brown (1974) reported that from the results of prior studies it can be concluded that persons with mental retardation are deficient in the use of control strategies, although they can be prompted to use these techniques. Persons with mental retardation may not be efficient at recognizing and using organizational patterns (August, 1980; Spitz, 1966), may not be able to understand categorical or organizational labels (Burger & Erber, 1976), or may lack the semantic network required to benefit from externally provided prompts to cluster (Bilsky, 1976; Engle & Nagle, 1979). McBane (1976) agreed that the ability to benefit from strategy use varies by developmental level. Results of the present study confirm that the use of control strategies was not sufficient to equate the performance of students with mental retardation with the performance of their peers without retardation. Nonetheless, when encoding strategies were externally supplied by the examiner, persons with mental retardation were able to use these strategies to enhance their recall performance.

Again, prior research findings are less clear on the effect of encoding strategies on automatically processed information. Fox and Rotatori (1979) reported that incidental learning is influenced by prior instructions to categorize, while Merrill (1992) found that encoding strategies can increase the speed of encoding. This later finding does not support the assumption that familiar stimuli are encoded automatically. Differential effects on strategy use with automatic processing have been found to be the result of materials and procedures used (Maisto & Jerome, 1977; Phillips & Nettelbeck, 1984), the type of information to be encoded (Ellis et al., 1989a), and the inability to encode beyond preliminary stages (Mar & Glidden, 1977). Bilsky et al. (1982) attributed deficits in strategy use to the inability to screen-out irrelevant information or attend to appropriate mediators in novel situations, both areas that effect performance on automatic processing tasks. Merrill (1992) concluded that the relationship between strategy use and automatic processing may be inconclusive because there may be some processes that can be executed without attentional resources but are performed better when resources are allocated to them.

In the present study, the encoding condition to which a participant was assigned was associated with recall performance but not relocation performance until retention interval was included in the analysis. All encoding conditions were not equally effective with all developmental

levels. These findings supplement the current literature that when retention of automatic processed information is expected, strategy use can increase performance.

Problems and Limitations

As with any research effort, it was not possible to control for all variables during the course of this study. Problems and limitations encountered during the study that should be considered in interpreting the data are reviewed in this section. Recommendations and suggestions for rectifying these problems in future research are also reviewed.

The procedures for the clustered encoding condition (Group 3) were selected based on previous suggestions that semantic encoding and semantic retrieval cues increased recall over the use of either strategy in isolation (Gerjuoy & Spitz, 1966; Mar & Glidden, 1977). Several participants verbally reported that they found encoding by categorical clusters confusing. It should be noted that participants from Group 3 had higher recall scores than participants from the other two groups, and a high number of intrusion errors experienced by this group was expected based on previous research into clustering and categorization (Evans & Bilsky, 1979). Nonetheless, blocked categorical presentation, showing items from a conceptual category contiguously, may have decreased confusion and increased recall.

A second limitation of the procedures of this study was the inability to test the effect of feedback on relocation

performance. Hasher and Zacks' theorized that automatic encoding would not benefit from either practice or feedback. No feedback was provided on day one's relocation performance to reduce the potential influence of day one's performance on day two. Therefore, it is unknown if feedback would have influenced performance differentially by developmental level.

A third limitation of the present study involved the performance on the relocation tasks. Performance below chance level by some participants classified as TMH may indicate an inability to encode information automatically or may be indicative of possible insensitivity of the measurement techniques (Hasher & Zacks, 1984). The procedures and instrument used in this study were based on those used by Ellis et al. (1987; 1989a) and Katz (1987). Steps taken to increase measurement sensitivity include (a) reducing the number of pictures to 50, (b) using black and white instead of color pictures to decrease the number of variables requiring encoding (Hasher & Zacks, 1984), and (c) pilot testing with students classified as TMH. During the relocation procedure, perseveration and patterning or naming quadrants in a preset order (i.e., 1,2,3,4) or naming the same quadrant repeatedly without overt attention to the picture being located was noted to occur with some TMH students. It is unknown if this patterning was a result of the procedures employed or a characteristic of perseveration patterns employed by students from this developmental level

(Ellis, Woodley-Zanthos, Dulaney, & Palmer, 1989b). Generally, these patterns could be broken by providing distractors such as asking the student to name the picture before naming its location.

A fourth limitation of the present study was incurred in the test of long-term memory. Turnure (1991) suggested that valid tests of memory, particularly long-term memory, should ensure that initial memory is uncontaminated by intertrial reminders or rehearsals. Turnure acknowledged that this is difficult to do with ecologically valid materials. Two problems were encountered in this respect in the present study. First, during the 4-minute recall phase, it was noted that some participants would look for environmental cues to increase recall. This appeared to be done more successfully by the students without mental retardation who might correctly recall pencil, computer, or desk after looking around the office used as the testing room. When the same strategy was used by the students classified as EMH, naming items not included in the original picture set increased. The strategy of searching the environment for recall cues did not appear to be applied by students classified as TMH. Nonetheless, it was apparent that environmental reminders did contaminate pure memory for some participants.

A second concern was in the measurement of long-term memory over the 24-hour recall period without reminders or rehearsals acting as intertrial contaminants as described by

Turnure (1991). In an attempt to decrease rehearsal, participants were told the 24-hour follow-up would consist of questions. They were not told that they would be asked to recall or relocate the pictures seen on day one, and no feedback was given concerning performance on day one. As the pictures were of common objects, however, it is reasonable to expect that reminders were noted during the 24-hour period and that at least some participants thought about, or mentally rehearsed, recalling the pictures.

Implications and Suggestions for Further Research

Within the context of the findings of this study and prior research into automatic and effortful memory processing, the following implications and suggestions for future research are made:

Implications

1. Based on the findings of lower performance by students classified as EMH and TMH in both automatic and effortful memory processing as a result of this investigation, performance differences should be considered in placement and program decisions. Decreased memory performance on effortful processing tasks supports previous findings. This research effort supplements previous limited evidence that cognitive performance differs under automatic processing conditions, especially when comparisons are made between persons of similar chronological ages. Differences in memory performance may be due to a decreased memory capacity, a decreased ability to produce memory strategies,

or an inability to select and attend to relevant stimuli (Merrill, 1990).

Additionally, anecdotal evidence revealed differences in processing strategies. Examiners reported that students without retardation frequently rehearsed picture order by repeating names of the pictures aloud or repeating names of pictures seen on previous pages; looked for environmental cues to increase recall; recalled items by category when not in the clustered encoding condition; recalled paired associates (e.g., bat and ball, car and truck); or recalled alphabetic clusters (e.g., bat, bed, book, ball). Use of these mediators was not noted routinely with students classified as TMH or EMH. Additionally, the increased study time required by students with mental retardation indicated that these students were slower at encoding.

Differences in memory performance are significant for both educators and persons in educational leadership positions. As educational programs are designed and placement decisions are made that encourage the inclusion of students of similar chronological ages, attention must be paid to designing programs that accommodate the differences in memory processing as shown by this investigation.

2. Based on the findings that students with mental retardation were deficient in relocation performance, attention needs to be paid by educators as to how learning occurs. The inability of students with mental retardation to benefit to the extent of their peers without retardation

from incidental learning situations supports Brown's (1974) contention that there is a relationship between mental maturity and the ability to disregard irrelevant information. Automatic processing deficits may compromise the ability to discriminate among stimulus events and efficiently use attentional resources, thereby limiting the capacity remaining for effortful processing (Katz, 1987). Furthermore, this deficit in automatic encoding ability may result in decreased retrieval abilities. Spitz (1966) described chaotic retrieval in persons with mental retardation as resulting from a failure to recognize and organize input.

Teachers therefore, should emphasize recognition and organization of those aspects of incoming information relevant for task performance, thus increasing the memory trace for to-be-remembered information and reducing over-all memory load. It should not be expected that spatial information or environmental cues will be attended to without specific direction to do so. Tasks should be analyzed into component strategies to determine what the student is expected to learn incidentally. Capacity requirements required for each task should be analyzed. Specific instructions and task-specific strategies should be used to maximize learning.

Deficiencies in relocation performance exhibited by students with mental retardation have particular importance in the design of functional training programs. Many

educational activities and most real-world experiences involve automatic encoding of such contextual cues as location, frequency, size, form, shape, and sequence. Spatial location skills, for example, are necessary not only to read a map or orient oneself to the environment but also for such tasks as following assembly line directions or arranging or collating materials.

3. Attention should be directed toward enhancement of automatic encoding skills. Failure of the performance of students with mental retardation to adhere to theoretical expectations for automatically encoded activities may be due either to task related variables or expectancies for failure. Turnure (1991) asserted that automatic encoding performance could be enhanced by practice, use of familiar materials and situations, and testing original learning situations. While this study did not address the effect of practice on automatic processing, evidence was provided that automatic encoding skills were present at some level for all study participants, regardless of developmental level. To enhance the development of these skills, Turnure (1991) recommended that testing situations parallel original learning situations as much as possible. The use of retrieval cues, according to Turnure, can enhance retrieval and reinstate learning. Materials should be related to meaningful goals and activities, and Short and Evans (1990) recommended specific assessment be performed of various

academic tasks so that the incidental and intentional learning required for the tasks can be delineated.

4. Based on the findings of this investigation, automatically processed information can be retained by both students with and without mental retardation. In this investigation, 24-hour follow-up of both recall and relocation performance was completed to determine the effect of long-term memory on automatic and effortfully processed information. Automatically processed information was not processed to as deep a level, and, therefore, it was not expected to be transferred into long-term memory. A significant finding of the study was that item relocation information was held in long-term memory as well by students with retardation, both TMH and EMH, as by students without retardation. Therefore, when steps are taken to facilitate automatic processing, as described in the previous implications, retention can occur both in students with and without retardation.

5. Based on the findings of that clustering and elaboration increased recall and relocation performance, attention needs to be paid to the enhancement of strategy use by both students with and without retardation. Additionally, the clustered encoding group had less deterioration of relocation information and higher gains in recall from day one to day two. While not all strategy use was equally effective with all groups, the clustered encoding group of TMH students was the only TMH subgroup to

show a gain in recall day one to day two. Based on this information, educators may be able to remediate performance problems by emphasizing relevant categorical aspects of incoming information.

Additionally, educators should not only teach strategic behaviors, but should also concentrate efforts on enhancement of the richness of existing knowledge and experiences. Engle and Nagle (1979) specified that comprehension and thus memory for new information could be increased by enabling the student to increase his or her semantic network.

Suggestions for Future Research

Future research efforts should concentrate on refining and extending the results of this study. The following recommendations to expand on this investigation are made:

1. Efforts should be made to include the effect of etiology on memory performance, particularly with students classified as TMH.

2. Replication of this investigation should be undertaken with other populations in order to extend the understanding of automatic and effortful processing with other age groups or participants from various residential and educational placements.

3. Replication of this study should be undertaken with other assessment measurements including computer assisted assessment.

4. Results of this investigation should be compared with similar assessments of effortful and automatic processing skills that followed strategic instruction and practice.

5. The effect of feedback on the use of automatically processed information should be assessed.

6. Factors which may affect automatic and effortful processing and retrieval such as attention, motivation, and locus of control should be included in future assessments.

A Final Comment

In summary, the results of this study have contributed to the continued growth of research on the memory of students with and without mental retardation. It was demonstrated that both automatic an effortful memory processing are influenced by the developmental level of the student and the conditions under which new information is received. Due to the effects of these mediating variables on automatic processing, support was not provided for the theory of automaticity as hypothesized by Hasher and Zacks (1979, 1984). These and other related findings of the present investigation are important to teachers and educational administrators in the design and implementation of educational programs for adolescents with mental retardation.

APPENDIX A
RESEARCH APPROVALS

January 25, 1994

TO: Ms. Suzanne B. Thomas, G-315 NRN

FROM: C. Michael Levy, Chair,
University of Florida Institutional Review Board

SUBJECT: Approval of Project#93.491
Recall ability as a function of cognitive encoding: A test of automaticity & clustering by students with & without mental retardation

I am pleased to advise you that the University of Florida Institutional Review Board has recommended the approval of this project. The Board concluded that your subjects will not be placed at risk in this research, and it is essential that you obtain legally effective informed consent from each participant's parent or legal guardian. When it is feasible, you should obtain signatures from both parents.

If you wish to make any changes in this protocol, you must disclose your plans before you implement them so that the Board can assess their impact on your project. In addition, you must report to the Board any unexpected complications arising from the project which affect your subjects.

If you have not completed this project by January 25, 1995, please telephone our office (392-0433) and we will tell you how to obtain a renewal.

By a copy of this memorandum, your Chair is reminded of the importance of being fully informed about the status of all projects involving human subjects in your department, and for reviewing these projects as often as necessary to insure that each project is being conducted in the manner approved by this memorandum.

CMH/h2

cc: Vice President for Research Unfunded
College Dean
P. Sindelar
Dr.Charles Forgnone

April 5, 1994

Ms. Suzanne Thomas
6929 West University Avenue
Apartment 2-C
Gainesville, Florida 32607

Dear Ms. Thomas:

I would like to inform you that your proposal for your dissertation study has been approved by Pinellas County Schools.

If you need any assistance in the future with your study I can be reached at 588-6255.

Sincerely,

Allen L. Mortimer, Ph.D.
Director of Planning and Policy

APPENDIX B
PARENT INFORMED CONSENT DOCUMENT

Dear Parents:

I am a doctoral student in Special Education at the University of Florida. As part of my dissertation research I am studying students' memory. I would like for your child to participate in this project. In this study, I will ask each student to look at several pictures. They will then be asked to name the pictures they remember. In addition, I will see how many pictures they remember the next day. Some of the students will be in special education. Others will not. Some students may be given cues to help them remember. For a cue I might ask them what an object is used for or I might show them two pictures that have things in common--such as a picture of a sock and a picture of a shoe. I will note, both on paper and on an audio tape recording, the number of pictures remembered, other information remembered about the pictures, the time it takes to study and recall the pictures, and if the cues increased recall. The tape recordings will be listened to by an independent observer who will double check my written recording of the data. The tapes will then be stored in case they are later needed to verify the results of the project. It is believed that the information learned from this study will help teachers know more about how information can be organized to increase the students' ability to remember.

This activity will take a total of approximately 30 minutes and will take place during the regular school day on two consecutive days. This activity will be separate from instruction ordinarily scheduled by the teacher. Those students who do not participate will continue with their regularly scheduled classes. Participants will be seen individually. A code will be assigned to each participant that will be used to identify both the written and audio taped reports. No actual names will be used in any reports, either written or oral. Only group scores will be published.

I am asking for your permission to (1) include your child in this project and (2) obtain achievement and other descriptive information from school records. Specifically, I am asking the school to make available:

special education classification (if applicable), IQ or achievement test results, age, race, and gender.

Participation in this project is voluntary. Participation or non-participation will not be reflected in your child's grades and will not affect your child in any way. You have the right to withdraw permission at any time for your child's participation or for me to use the data learned from your child. In addition, if your child does not want to participate in the activity, or doesn't want to answer a specific question, he or she does not have to. There will be no compensation for participation other than a small thank-you gift. No risks are anticipated. If you agree for your child to participate, I would appreciate your telling your child that a researcher from the University will be coming to his or her school within the next few weeks and that it is okay to talk to me. If you have any questions about any aspects of this project, please call Suzanne Thomas, 904-331-3906, or 904-392-0701.

Please sign the Parent Informed Consent Form at the bottom of this page and return it in this envelope. Your assistance is greatly appreciated as the information learned in this study will be important in designing educational programs in the future.

Sincerely,

Suzanne B. Thomas, MBA, M.Ed.

Clip and retain this portion for future reference

Return this portion to your child's teacher immediately

I have read and I understand the procedure for the project described above. I give permission (1) for my child ____________________________________, to participate in this study of memory and information processing and (2) achievement and other descriptive information to be obtained from my child's school records for use during this study.

I have received a copy of the description of this project. I understand that all information will remain confidential with respect to the identity of my child and that I may withdraw my consent for my child's participation at any time I wish.

Parent/Guardian	Date	2nd Parent/Witness	Date

APPENDIX C
INSTRUCTIONS FOR EXAMINERS

DAY ONE

1. Each child should be taken to a quiet location where he or she can sit comfortably across the table from you with room for you to hold the picture book upright for the student to see while at the same time your script and data sheet is within easy distance for you to see and mark responses.

2. Read the Child Assent Script.

3. Write the student's name and encoding condition on the cover sheet of the appropriate data sheet packet. White is nonsemantic encoding (group 1); Green is semantic encoding (group 2); yellow is clustered encoding (group 3).

4. Write the student ID number on every page of the data sheets. The ID number is assigned based on:
   first digit = school code
   second digit = teacher code
   third digit = student code

   See attached list of school and teacher codes.

5. Write the tape number on the cover sheet and verbally record the ID number of the student on the audio tape.

6. Read the Practice Set portion of the script for Day One-Test One for the appropriate encoding condition group (Note: Scripts are color coded to match the data sheets.)

7. Complete the Recall Test of the Practice Set.

8. Begin tape recording.

9. Begin the memory portion of the task by:
   (a) Reading from the appropriate script

   (b) Following the instructions printed in *italics* on each script for marking the data sheets.

   - If a student is not able to name a picture, the name can be furnished by the examiner. Any

student not able to identify 2 pictures should complete this phase (viewing all 50 pictures). He or she should then be thanked for participation, given a thank-you gift, and excused from the remainder of the task.

- Appropriate substitutions of item recognition (e.g., hamburger/sandwich; truck/van) should be noted with a check mark by the item on the data sheet. The substitution should be counted as correctly recalled if the item is recalled by the same name as it is originally identified by the student. The substitution (or name called by the student) should be noted on the data sheet at the end of the session after the student leaves the examination area. This will enable you to count correctly recalled substitutions on Day 2.

- Any item recalled by the student which was not included in the set of pictures (an intrusion error) should be marked with a hash mark in the appropriate place on the data sheet.

10. Continue the relocation portion of the task following the instructions from the appropriate script.

DAY TWO

11. Read and follow Day Two-Test One script for the appropriate group.

12. Complete the recall follow-up task.

13. Complete the relocation follow-up task from Day Two-Test Two script.

14. Ensure the student ID number is on every page of the data sheet.

APPENDIX D
SCRIPTED INSTRUCTIONS FOR EXPERIMENTAL ENCODING CONDITIONS

CHILD ASSENT SCRIPT

My name is ________________. I go to school (am working on a project) at the University of Florida. Are you a Florida Gator fan? I am working on a special project to study what different people learn and remember.

This morning (afternoon) I want to do an activity with you for this project. Since it is for my school (or for a project at the University) you won't get a grade on it. It will be like playing a game. I will show you some pictures and then ask you some questions about them. I will write down some things you remember about the pictures, plus what we say will be recorded on this tape recorder (indicate tape recorder). You will get a small prize when we are through. Also, I will come back tomorrow to play part of the picture game again.

Did your Mom or Dad tell you that I would be here working on this project?

Is it OK for me to show you the pictures and ask you some questions about them?

I will want to ask you questions again tomorrow. Is that OK?

This will only take a few minutes, but if you want to stop at any time, just let me know.

GROUP 1 - NONSEMANTIC ENCODING
DAY ONE - TEST ONE

"First, I want to show you a book of pictures. I want you to try to remember as many as you can. To help you remember, I want you to name each picture out loud as you look at it. You can look at each picture for as long as you like, and say the name as many times as you want to. But once I have turned the page you cannot go back and look at it again. Tell me when you are ready for me to turn the page. If you don't know what a picture is, tell me and I can tell you the name."

"Let's look at the first couple of pages of pictures just for practice. After you look at these pages I'm going to ask you to name as many pictures as you can, so I want you to remember them. Be sure to say the name of the picture out loud.

1. *Show the first 8 pictures (2 pages) in the practice set.*
2. *Have the student look at and name each picture aloud.*

- *If a student calls the picture by an appropriate name other than the name shown (e.g., sandwich for hamburger), place a check mark on the data sheet and write the name used by the student on the data sheet following the test.*

"Now let's close the book and I want you to tell me as many pictures as you remember. I'll mark them down as you call them out."

1. *Give 1 minute for recall.*
2. *Mark on <u>Data Sheet - Practice Set</u> the pictures recalled and the order of recall (the first picture recalled will be #1, the second picture will be #2, etc.).*

- *For any item named by the student that was not included in the original set, a mark should be made in the "Intrusion" column.*

"Now, we will do the same thing again. There will just be more pictures this time. Be sure to say the name of the pictures out loud to help you remember better just like you did this time. Remember, you can look at the pictures for as long as you want and say the name as many times as you want, but once you have told me to turn the page, you can't go back."

1. *Show the 50 pictures in the remainder of the book following the instructions above for appropriate substitutions.*

2. *Mark the study time (the time that the student used to look at and name all of the pictures) on the top of* Data Sheet #1.

"Just like we did before, I am going to close the book and I want you to tell me as many pictures as you can remember. I will mark them down again as you name them. You will have four minutes to name as many as you can. That's a pretty long time, so take your time. Just remember as many as you can."

1. *Give 4 minutes for recall.*
2. *Mark on* Data Sheet #1 *the pictures recalled following instructions above for recall order and intrusion errors.*

GROUP 1
DAY TWO - TEST ONE

"Do you remember looking at pictures in this book yesterday?"

Hold up book or point to it, but do not show pictures in it.

"Today, I want to see how many of the pictures you remember from yesterday. I will mark them down as you call them out, just like we did yesterday. Again, you will have four minutes to remember as many as you can, so take your time."

1. *Give 4 minutes for recall.*
2. *Mark on* Data Sheet #5 *the pictures recalled, the order of recall (the first picture recalled will be #1, the second picture will be #2, etc.), and intrusion errors.*

GROUP 2 - SEMANTIC ENCODING
DAY ONE - TEST ONE

"First, I want to show you a book of pictures. I want you to try to remember as many as you can. To help you remember, I want you to name each picture aloud as you look at it. I also want you to tell me what it is used for or something you think is interesting about the picture. For example, if I show you a picture of a spoon, you might tell me you use it to eat cereal with. If I showed you a picture of a police officer you might tell me that police officers help you if you are lost or that they wear uniforms. Just whatever you think is interesting about police officers. You can look at each picture for as long as you like, and say the name and something interesting as many times as you want to. But once I have turned the page you cannot go back and look at it again. Tell me when you are ready for me to turn the page. If you don't know what a picture is, tell me and I can tell you the name."

"Let's look at the first couple of pages just for practice. After you look at these pages I'm going to ask you to name as many pictures as you can, so I want you to remember them. Be sure to say the name of the picture out loud and tell me something it is used for or something interesting about it."

1. *Show the first 8 pictures (2 pages) in the practice set.*
2. *Have the student look at and name each picture aloud.*

- *If a student calls the picture by an appropriate name other than the name shown (e.g., sandwich for hamburger), place a check mark on the data sheet and write the name used by the student on the data sheet at the end of the test.*

"Now let's close the book and I want you to tell me as many pictures as you remember. I'll mark them down as you call them out."

1. *Give 1 minute for recall.*
2. *Mark on <u>Data Sheet - Practice Set</u> the pictures recalled and the order of recall (the first picture recalled will be #1, the second picture will be #2, etc.).*

- *For any item named by the student that was not included in the original set, a mark should be made in the <u>"Intrusion"</u> column.*

"Now, we will do the same thing again. There will just be more pictures this time. Be sure to say the name of the pictures out loud and tell me what each item is used for or something interesting about each thing to help you remember better - just like you did this time. Remember, you can

look at the pictures for as long as you want and say the name and something interesting as many times as you want to, but once I have turned the page, you can't go back."

1. *Show the 50 pictures in the remainder of the book., following above instructions for appropriate substitutions.*
2. *Mark the study time (the time that the student used to look at and name all of the pictures) on the top of* Data Sheet #2.

"Just like we did before, I am going to close the book and I want you to tell me as many pictures as you can remember. I will mark them down again as you name them. You will have four minutes to name as many as you can. That's a pretty long time, so take your time. Just remember as many as you can."

1 *Give 4 minutes for recall.*
2. *Mark on* Data Sheet #2 *the pictures recalled, the order of recall (the first picture recalled will be #1, the second picture will be #2, etc.), and intrusion errors.*

GROUP 2
DAY TWO - TEST ONE

"Do you remember looking at pictures in this book yesterday."

Hold up book or point to it, but do not show pictures in it.

"Today, I want to see how many of the pictures you remember from yesterday. I will mark them down as you call them out, just like we did yesterday. Again, you will have four minutes to remember as many as you can, so take your time."

1. *Give 4 minutes for recall.*
2. *Mark on* Data Sheet #6 *the pictures recalled ,the order of recall (the first picture recalled will be #1, the second picture will be #2, etc..), and intrusion errors.*

GROUP 3 - CLUSTERED ENCODING
DAY ONE - TEST ONE

"First, I want to show you a book of pictures. I want you to try to remember as many as you can. To help you remember, I want you to name each picture aloud as you look at it. I also want you to tell me something else that is like the picture you saw. For instance, I might show you a piano and you know a horn also plays music, so you might say piano and horn. You may even see several pictures that have things in common--like horn and piano. You can look at each picture for as long as you like, and say the name and another thing like it as many times as you want to. But, once I have turned the page you cannot go back and look at it again. Tell me when you are ready for me to turn the page. If you don't know what a picture is, tell me and I can tell you the name."

"Let's look at the first couple of pages of pictures just for practice. After you look at these pages I'm going to ask you to name as many pictures as you can, so I want you to remember them. Be sure to say the name of the picture out loud and name something else like it. "

1. *Show the first 8 pictures (2 pages) in the practice set.*
2. *Have the student look at and name each picture aloud. After each picture is named, cue the student to name something from the same conceptual category by asking:*

"Can you tell me another ....(musical instrument or type of building)?

- If a student calls the picture by an appropriate name other than the name shown (e.g., sandwich for hamburger), place a check mark on the data sheet and write the name used by the student on the data sheet following the test.

"Now let's close the book and I want you to tell me as many pictures as you remember. I'll mark them down as you call them out. First, I want you to tell me as many MUSICAL INSTRUMENTS as you can remember. Now, tell me the BUILDINGS you remember."

1. *After the student names as many as can be remembered from the first category, he/she is asked to name as many as can be remembered from the second category.*
2. *Give 1 minute for recall.*
3. *Mark on <u>Data Sheet - Practice Set</u> the pictures recalled and the order of recall (the first picture recalled will be #1, the second picture will be #2, etc.).*

- For any item named by the student that was not included in the original set, a mark should be made in the "Intrusion" column.

"Now, we will do the same thing again. There will just be more pictures this time. Be sure to say the name of the pictures out loud and say another thing that is like it to help you remember better, just like you did this time. Remember, you may see several pictures that have something in common. You can look at the pictures for as long as you want and say the name and something like it as many times as you want, but once I have turned the page, you can't go back."

1. *Show the 50 pictures in the remainder of the book following the instructions above. for appropriate substitutions.*
2. *Mark the study time (the time that the student used to look at and name all of the pictures) on the top of <u>Data Sheet #3</u>.*

"Just like we did before, I am going to close the book and I want you to tell me as many pictures as you can remember. I will mark them down again as you name them. You will have four minutes to name as many as you can. That's a pretty long time, so take your time. Just remember as many as you can. Now, tell me the pictures of ______ that you remember."

1. *After the student names those that can be remembered from the first category, he/she is asked to name as many as can be remembered from the second category. Requests are continued until all categories have been named. The order of categories is indicated on <u>Data Sheet #3</u>.*
2. *Give 4 minutes for recall.*
3. *Mark on <u>Data Sheet #3</u> the pictures recalled , the order of recall (the first picture recalled will be #1, the second picture will be #2, etc.), and intrusion errors.*

GROUP 3
DAY TWO - TEST ONE

"Do you remember looking at pictures in this book yesterday?"

Hold up book or point to it, but do not show pictures in it.

"Today, I want to see how many of the pictures you remember from yesterday. I will mark them down as you call them out, just like we did yesterday. Again, you will have four minutes to remember as many as you can, so take your time. Now, tell me the pictures of ______ that you remember."

1. *After the student names those that can be remembered from the first category, he/she is asked to name as many as can be remembered from the second category. Requests are continued until all categories have been named. The order of categories is indicated on Data Sheet #7. "*
2. *Give 4 minutes for recall.*
3. *Mark on Data Sheet #7 the pictures recalled, the order of recall (the first picture recalled will be #1, the second picture will be #2, etc.). and intrusion errors.*

ALL GROUPS
DAY ONE - TEST TWO

"Now, the second thing I want you to do is look at these pictures in this stack. They are just like the first ones you saw in the book. Do you remember this picture?"

Show one picture from the practice set.

"When you saw it in the book, was it in this corner, this corner, etc.?"

Indicate each quadrant by holding the picture from the practice set over each quadrant as you say "this corner, this corner. . . ." When the student points to or indicates a quadrant, show how the picture can be inserted into the notebook so the student can see how the picture looks when it is relocated. The picture is then removed by the examiner. No indication (either verbal or gestural) is made of correctness.

"Now, let's look at all the pictures you have just seen. I want you to tell me where you saw each one."

1. *Hand or show the student each picture, one at a time, from the recall test set until all 50 pictures have been relocated..*

2. *Have the participant indicate the quadrant where he/she thinks the picture first appeared either by point to, naming, or giving the number of the quadrant. No indication (verbal or gestural) is made to indicate correctness.*

3 *Mark on Data Sheet #4 the quadrant where each picture is relocated by the student.*

- *Left upper corner is #1; left lower, #2; right upper corner is #3; right lower is #4.*

ALL GROUPS
DAY TWO - TEST TWO

"Now, let's look at the pictures again. Do you remember yesterday you told me the corner where you first saw each picture. I want you to do that for me again today."

"When you first saw this picture in the book, was it in this corner, this corner, etc."

1. *Hand or show the student each picture, one at a time, from the recall test set until all 50 pictures have been relocated..*

2. *Have the participant indicate the quadrant where he/she thinks the picture first appeared either by point to, naming, or giving the number of the quadrant. No indication (verbal or gestural) is made to indicate correctness.*

3. *Mark on <u>Data Sheet #8</u> the quadrant where each picture is relocated by the student.*

   - *Left upper corner is #1; left lower, #2; right upper corner is #3; right lower is #4.*

APPENDIX E
DATA SHEETS FOR RECORDING
RECALL AND RELOCATION RESPONSES

STUDENT NAME ______________________

ENCODING GROUP ___________________
(1 - Nonsemantic; 2 = Semantic; 3 = Clustered)

STUDENT ID # ________________________

DISTRICT ____________________________

SCHOOL ______________________________

TAPE # _______

Student Id # ____________________

DATA SHEET - PRACTICE SET
ALL GROUPS

ITEM	RECALL ORDER
Barn	
House	
Church	
School	
Piano	
Horn	
Guitar	
Drum	
Intrusions	

STUDENT ID #____________
STUDY TIME ______

DAY ONE - TEST ONE
GROUP 1
Data Sheet #1

ITEM	RECALL ORDER
Airplane	
Apple	
Ball	
Bat	
Bed	
Belt	
Bicycle	
Book	
Car	
Cat	
Chair	
Computer	
Cow	
Cup	
Desk	
Dress	
Doll	
Ear	
Eye	
Fire truck	
Fish	
Foot	
Fork	
Hand	
Hamburger	
Hammer	
Hat	
Horse	

ITEM	RECALL ORDER
Ice Cream	
Kite	
Ladder	
Lips	
Milk	
Paintbrush	
Pan	
Pencil	
Pie	
Rabbit	
Ruler	
Saw	
Scissors	
Shoe	
Shovel	
Sofa	
Spoon	
Suit	
Table	
Toaster	
Train	
Truck	
Intrusions	

______ TOTAL # ITEMS RECALLED

STUDENT ID #____________
STUDY TIME ______

DAY ONE - TEST ONE
GROUP 2
Data Sheet #2

ITEM	RECALL ORDER
Airplane	
Apple	
Ball	
Bat	
Bed	
Belt	
Bicycle	
Book	
Car	
Cat	
Chair	
Computer	
Cow	
Cup	
Desk	
Dress	
Doll	
Ear	
Eye	
Fire truck	
Fish	
Foot	
Fork	
Hand	
Hamburger	
Hammer	
Hat	
Horse	

ITEM	RECALL ORDER
Ice Cream	
Kite	
Ladder	
Lips	
Milk	
Paintbrush	
Pan	
Pencil	
Pie	
Rabbit	
Ruler	
Saw	
Scissors	
Shoe	
Shovel	
Sofa	
Spoon	
Suit	
Table	
Toaster	
Train	
Truck	
Intrusions	

______ TOTAL # ITEMS RECALLED

STUDENT ID #___________
STUDY TIME _____

DAY ONE - TEST ONE
GROUP 3
Data Sheet #3
REQUEST RECALL BY CATEGORY IN ORDER LISTED

ITEM	RECALL ORDER
Animals	
Cat	
Cow	
Fish	
Horse	
Rabbit	
Body Parts	
Ear	
Eye	
Foot	
Hand	
Lips	
Food	
Apple	
Hamburger	
Ice Cream	
Milk	
Pie	
Toys	
Ball	
Bat	
Bicycle	
Kite	
Doll	
Clothing	
Belt	
Dress	
Hat	
Shoe	
Suit	
Intrusions	

ITEM	RECALL ORDER
Vehicles	
Airplane	
Car	
Fire Truck	
Train	
Truck	
Kitchen Utensils	
Cup	
Fork	
Pan	
Spoon	
Toaster	
Furniture	
Bed	
Chair	
Desk	
Sofa	
Table	
Tools	
Hammer	
Ladder	
Paintbrush	
Saw	
Shovel	
School Supplies	
Book	
Computer	
Pencil	
Ruler	
Scissors	

_____ TOTAL # ITEMS RECALLED

STUDENT ID # ___________

DAY ONE - TEST TWO
ALL GROUPS
Data Sheet #4

ITEM	NAMED QUADRANT	ACTUAL QUADRANT	CORRECTLY RELOCATED	RE-CALLED?
Table		2		
Ruler		3		
Fork		4		
Ice Cream		1		
Fire Truck		2		
Apple		4		
Hand		3		
Horse		1		
Belt		4		
Airplane		1		
Pan		4		
Dress		2		
Rabbit		1		
Train		4		
Ladder		3		
Fish		1		
Milk		3		
Sofa		2		
Eye		1		
Scissors		2		
Cat		1		
Shovel		3		
Suit		1		
Chair		4		
Pie		2		
Hat		4		
Car		3		
Hammer		4		
Saw		2		
Book		3		
Ball		1		
Paintbrush		4		
Lips		3		
Kite		2		
Desk		3		
Doll		1		
Ear		3		
Pencil		1		

Student ID # ________

DAY ONE - TEST TWO
ALL GROUPS
Data Sheet #4 (Page 2)

ITEM	NAMED QUADRANT	ACTUAL QUADRANT	CORRECTLY RELOCATED	RE-CALLED?
Bed		2		
Toaster		4		
Foot		2		
Truck		3		
Shoe		4		
Cup		1		
Bat		2		
Hamburger		3		
Computer		2		
Bicycle		1		
Cow		4		
Spoon		2		

________ TOTAL # ITEMS CORRECTLY RELOCATED

* NAMED QUADRANT:
1 = LEFT UPPER; 2 = LEFT LOWER
3 = RIGHT UPPER; R = RIGHT UPPER

STUDENT ID #____________

DAY TWO - TEST ONE
GROUP 1
Data Sheet #5

ITEM	RECALL ORDER
Airplane	
Apple	
Ball	
Bat	
Bed	
Belt	
Bicycle	
Book	
Car	
Cat	
Chair	
Computer	
Cow	
Cup	
Desk	
Dress	
Doll	
Ear	
Eye	
Fire truck	
Fish	
Foot	
Fork	
Hand	
Hamburger	
Hammer	
Hat	
Horse	

ITEM	RECALL ORDER
Ice Cream	
Kite	
Ladder	
Lips	
Milk	
Paintbrush	
Pan	
Pencil	
Pie	
Rabbit	
Ruler	
Saw	
Scissors	
Shoe	
Shovel	
Sofa	
Spoon	
Suit	
Table	
Toaster	
Train	
Truck	
Intrusions	

______ TOTAL # ITEMS RECALLED

STUDENT ID ________________

DAY TWO - TEST ONE
GROUP 2
Data Sheet #6

ITEM	RECALL ORDER
Airplane	
Apple	
Ball	
Bat	
Bed	
Belt	
Bicycle	
Book	
Car	
Cat	
Chair	
Computer	
Cow	
Cup	
Desk	
Dress	
Doll	
Ear	
Eye	
Fire truck	
Fish	
Foot	
Fork	
Hand	
Hamburger	
Hammer	
Hat	
Horse	

ITEM	RECALL ORDER
Ice Cream	
Kite	
Ladder	
Lips	
Milk	
Paintbrush	
Pan	
Pencil	
Pie	
Rabbit	
Ruler	
Saw	
Scissors	
Shoe	
Shovel	
Sofa	
Spoon	
Suit	
Table	
Toaster	
Train	
Truck	
Intrusions	

_____ TOTAL # ITEMS RECALLED

STUDENT ID #____________

DAY TWO - TEST ONE
GROUP 3
Data Sheet #7

REQUEST RECALL BY CATEGORY IN ORDER LISTED

ITEM	RECALL ORDER
Tools	
Hammer	
Ladder	
Paintbrush	
Saw	
Shovel	
Furniture	
Bed	
Chair	
Desk	
Sofa	
Table	
Animal	
Cat	
Cow	
Fish	
Horse	
Rabbit	
Food	
Apple	
Hamburger	
Ice Cream	
Milk	
Pie	
School Supplies	
Book	
Computer	
Pencil	
Ruler	
Scissors	
Intrusions	

ITEM	RECALL ORDER
Kitchen Utensils	
Cup	
Fork	
Pan	
Spoon	
Toaster	
Clothing	
Belt	
Dress	
Hat	
Shoe	
Suit	
Vehicles	
Airplane	
Car	
Fire Truck	
Train	
Truck	
Body Parts	
Ear	
Eye	
Foot	
Hand	
Lips	
Toys	
Ball	
Bat	
Bicycle	
Kite	
Doll	

_____ TOTAL # ITEMS RECALLED

STUDENT ID # ___________

DAY TWO - TEST TWO
ALL GROUPS
Data Sheet #8

ITEM	NAMED QUADRANT	ACTUAL QUADRANT	CORRECTLY RELOCATED	RE-CALLED?
Paintbrush		4		
Desk		3		
Cup		1		
Pie		2		
Hat		4		
Ball		1		
Ear		3		
Hammer		4		
Suit		1		
Chair		4		
Book		3		
Saw		2		
Lips		3		
Bed		2		
Train		4		
Sofa		2		
Belt		4		
Car		3		
Scissors		2		
Hamburger		3		
Foot		2		
Shovel		3		
Pencil		1		
Ladder		3		
Table		2		
Truck		3		
Computer		2		
Horse		1		
Kite		2		
Toaster		4		
Fish		1		
Bat		2		
Doll		1		
Shoe		4		
Bicycle		1		
Pan		4		
Cat		1		
Dress		2		

Student ID # _________

DAY TWO - TEST TWO
ALL GROUPS
Data Sheet #8 (Page 2)

ITEM	NAMED QUADRANT	ACTUAL QUADRANT	CORRECTLY RELOCATED	RE-CALLED?
Eye		1		
Spoon		2		
Hand		3		
Apple		4		
Fire Truck		2		
Fork		4		
Airplane		1		
Cow		4		
Ice Cream		1		
Ruler		3		
Rabbit		1		
Milk		3		

__________ TOTAL # ITEMS CORRECTLY RELOCATED

* NAMED QUADRANT:
1 = LEFT UPPER; 2 = LEFT LOWER
3 = RIGHT UPPER; 4 = RIGHT LOWER

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BIOGRAPHICAL SKETCH

Suzanne Thomas was born in Sulphur Springs, Texas, August 6, 1948. She graduated from Sulphur Springs High School in 1966 and she received a Bachelor of Science degree from East Texas State University in general business and business education in 1969.

Following graduation, Suzanne worked as an administrator for a national insurance company until, in 1977, she began what has become a career in human services. She worked for 6 years with the Texas Department of Human Services and for 10 years with the Texas Department of Mental Health and Mental Retardation and with a regional mental retardation authority. During this time she became interested in learning principles, in the administration of residential programs for persons with disabilities, and in community integration and transition issues. She attended the University of North Texas and received a Master of Business Administration degree in administrative management in 1988 and a Master of Education degree in special education in 1990.

In 1991 Suzanne moved to Florida and entered the doctoral program in special education administration.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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